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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND B. ALFRED RAWORTH.

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See half-page Advertisement, last and next week.

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See Full Page Advt., page 54, Feb. 8.

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See half-page Advertisement page 82, Jan. 25.

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TENDERS.

PORT OF BRISTOL.

FERRO-CONCRETE BUILT SUPERSTRUCTURE FOR COLD STORES, AVONMOUTH DOCKS.

The Docks Committee invite

Tenders for the Construction

and Maintenance of a Ferro-Concrete built Superstructure for Cold Stores, Avonmouth Docks.
On and after Monday, the 18th February, 1918, copy of the form of Tender, General Conditions, Specification, and Schedule of Quantities, and a copy of the Contract Drawings, can be obtained from the undersigned on production of a receipt showing that a deposit of £5 has been paid to the Secretary of the Docks Committee, to whom all cheques must be made payable. The deposit of £5 will be returned to all bona fide tenderers hereafter.
Tenders must be enclosed in a sealed envelope, endorsed "Tender for Superstructure for Cold Stores," and addressed to the Secretary of the Docks Committee, Docks Office, 19, Queen Square, Bristol, and must be delivered to him accompanied by the prescribed documents and drawings before Ten a.m. on Monday, the 11th March, 1918.
The Docks Committee do not bind themselves to accept the lowest or any tender.
THOMAS A. PEACH, Engineer.
Docks Engineer's Office,
Avonmouth Docks,
Bristol.
5th February, 1918. K 308

Re the TANDEM SMELTING COMPANY, Ltd.
By Order of B. D. HOLROYD, Esq., F.C.A., the Controller appointed by the Board of Trade, Messrs. FULLER, HORSEY, SONS & CASSELL are instructed to invite

Tenders for the Purchase of

the undermentioned:—
VALUABLE LETTERS PATENT
granted to Herbert Frederick Hoveler for improvements in
LIQUID FUEL BURNERS.

No. of Patent.	Date Granted.	Period.	Country.
105113	Mar. 30, '16	14 yrs.	Great
6644/'10	Mar. 16, '10	14 yrs.	Britain and
21675/'07	Sept. 30, '07	14 yrs.	Ireland.

The Burners may, by permission of the Occupiers, be seen in operation at the Tandem Smelting Works, Merton Abbey, on Steam Boilers and Smelting Furnaces, and every opportunity will be afforded intending purchasers to satisfy themselves as to the merits claimed by the Patentee. There will be included in the purchase the
STOCK OF BURNERS,
Spare Parts and Accessories, now stored at the Merton Abbey Works.
Tenders, which must be in the form contained in the Particulars, should be delivered under seal marked "Tender for Burner Patents," at the Offices of the Controller, B. D. HOLROYD, Esq., F.C.A., 6, Great Winchester Street, by Twelve o'clock noon, on Monday, February 25th, 1918.
Particulars of the Patents, with Conditions of Sale and the opinion of Mr. A. J. WALKER, K.C., thereon, may be had when ready of Messrs. HOLROYD, WEST & NORTHCOTT, Chartered Accountants, 6, Great Winchester Street, E.C. 2; of Messrs. MAWBY, MAWBY & MORRIS, Solicitors, 6 & 7, Queen Street, Cheapside, E.C. 4, or of Messrs. FULLER, HORSEY & CO., 133, High Holborn, W.C. 1. K 341

APPOINTMENTS OPEN.

The Committee of the Great

Northern Central Hospital, Holloway, N., would be pleased to receive APPLICATIONS from Members of the Institution of Mechanical Engineers for the Office of HONORARY CONSULTING MECHANICAL ENGINEER to the above Institution. The Hospital contains 405 beds, 270 of which are for wounded soldiers.—Particulars of the appointment will be gladly sent by the SECRETARY. K 381

Wanted, in Government

Factory, METALLURGICAL CHEMIST, able to control pyrometers, including standardisation and up-keep, with thorough knowledge of photo-micrography of steel and non-ferrous alloys and general routine of metallurgy. No person already engaged on Government work need apply.—Apply your nearest EMPLOYMENT EXCHANGE, quoting No. A 4532. K 127

METROPOLITAN
BOROUGH OF HAMMERSMITH.

ELECTRICITY DEPARTMENT.

The Council of the Metropolitan Borough of Hammersmith invite

Applications from Properly

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(a) METER SUPERINTENDENT.
Salary £160 per annum, rising by two annual increments of £7 10s. to £175 per annum, plus War Bonus of 20s. weekly.
(b) ENGINEER-IN-CHARGE.
Salary £175 per annum, rising by annual increments of £12 10s. to £200 per annum, plus War Bonus of 20s. weekly.
The appointment will be subject to one week's notice on either side, in each case.
Applications, stating experience and accompanied by copies of three recent testimonials, must be delivered to the Borough Electrical Engineer, Electricity Works, 95, Fulham Palace Road, Hammersmith, W. 6, not later than Thursday, February 21st.
Candidates canvassing members of the Borough Council will be disqualified.
Town Hall, LESLIE GORDON,
Hammersmith, W. 6, Town Clerk.
5th February, 1918. K 311

Chief Analytical Chemist

REQUIRED by large Engineering Firm, to take charge of Chemical Laboratory, controlling Machine Shops, Iron Foundries and Bronze Foundries. Candidates must have first-class experience in connection with the analysis of all kinds of High Speed, Alloy and Straight Steels, and be thoroughly conversant with the laboratory work in connection with iron and bronze foundries, including the control of cupolas. Applicants should give full particulars of their training and particularly their foundry experience, also state age and salary required. The position is permanent and holds good prospects for suitable man. No person employed on Government work will be engaged.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning Engineering and quoting No. A 4680. K 368

General Works Chemist; also

a CHEMIST with Micro-metallographic experience for work in connection with Aero and Motor construction. No one already on Government work will be engaged.—Reply, stating experience, age, salary expected, to LABOUR DEPARTMENT, Austin Motor Co., Ltd., Longbridge Works, Northfield, Birmingham. K 172

The Grammont Establish-

ments WANT Engineering CHEMISTS or METALLURGISTS, well up in the treatment of copper ores of all kinds. Good positions, with financial interests in results.—Address, CUIVRE ELECTRO A. GRAMMONT, 10 Rue d'Uzès à Paris. K 385

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Engineers' Buyer or Drawing

Office ORDER CLERK WANTED, preference given to one having experience in locomotive and light railway work, also estimating (he would be required to deal with all shop orders and materials). Only competent, experienced men need apply, and no person already engaged on Government work would be engaged. State experience, age and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4678. K 394

General Manager Required

by the BIRMINGHAM CORPORATION GAS DEPARTMENT.
Applications are invited from gentlemen possessing sound commercial qualifications, and the ability and tact necessary to control a large staff. A knowledge of gas manufacture is not essential, but a good general engineering experience and some knowledge of the chemical industry are necessary.
Applications (stating age, experience and salary required), which will be treated as confidential, to be addressed to—
Alderman SIR HALLEWELL ROGERS,
Chairman of the Gas Committee,
Gas Department,
Council House,
Birmingham.

Wanted, Works Manager, for

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a thoroughly competent WORKS MANAGER, up to all modern shop practice, to take entire charge of a large factory concerned in the manufacture of electrical and scientific apparatus. Good salary to first-class man.—Address, K 275, Offices of Engineering.

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Experienced Business MAN, with good organising ability, is REQUIRED, to take charge of a large Stores Department in Aircraft Works, London District. Write, stating age, experience and salary required. Only first-class men need apply. No one will be engaged who is resident more than ten miles away or engaged on Government work.—Address, K 347, Offices of Engineering.

Wanted, Erecting Engineer,

with experience in the erection of large coke oven plants, for firm in the Sheffield District. Apply, giving full experience, salary required, &c. —Address, K 273, Offices of Engineering.

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for leading Magneto manufacturers. Magneto experience preferred, but experience in small electrical work essential. No one on Government work or resident more than ten miles away will be employed. State age, full experience and salary required.—Address, K 378, Offices of Engineering.

Engineers and Draughtsmen,

accustomed to preparation of plans and riverside works, WANTED immediately. — Apply, GRIFFITHS, 3, Central Buildings, Westminster. K 345

Wanted, Engineer, Marine

Certificate, Assistant Estate, East Africa, Salary according to qualifications. — MASHNO, 1 and 2, George Street, Mansion House, E.C. K 303

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DRAUGHTSMEN, with previous experience of design of ferro-concrete structures, REQUIRED by L. G. MOUCHEL & PARTNERS, Ltd., 38, Victoria Street, S.W. 1.—Apply by letter, stating age, experience, and salary required. K 364

Civil Engineering Assistants,

with experience in public work constructions, WANTED immediately for Government work on South Coast; men who have acted as Sub-Agents preferred. Applicants must be ineligible for General Service, and should give full particulars of their experience and qualifications, with references or copy of testimonials, and state salary required. —BOX D.W.M.N.926, Willing's, 125, Strand, W.C. 2. K 422

Assistant Station Engineer

REQUIRED, night work only, for Electric Generating Station. Knowledge of steam turbines, water tube boilers and high tension A.C. current essential. No person already on Government work will be engaged.—Write, stating age, full details of experience and salary required, to BOX, 9371, care of A. J. Wilson & Co., Ltd., 154, Clerkenwell Road, London, E.C. 1. K 421

A Large Aircraft Firm,

manufacturing machines of their own design, REQUIRE the SERVICES of a number of really good Mechanical DRAUGHTSMEN, who have had a thorough theoretical and practical training as well as some experience in aeroplane design and construction. Opportunities above the average exist for men residing in London to whom the above description applies. No one already engaged on Government work or residing more than 10 miles away need apply.—Write, stating age, past experience and salary required, to K 402, Offices of Engineering.

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Draughtsman Wanted, with

first-class Mechanical Engineering experience. Some knowledge of Lifting Machinery an advantage. Apply to your nearest EMPLOYMENT EXCHANGE, stating age, experience and salary required, mentioning No. A 4435. No person already engaged on Government work need apply. K 63

First-class Draughtsmen

with good general experience WANTED by large Controlled Firm in South Yorkshire.—Address, giving full particulars of experience, and salary required (inclusive of War Bonus), J 348, Offices of Engineering J 348

Draughtsman (Senior)

REQUIRED for Experimental Engineer's Department, varied work. Quick promotion for good man. No one already on Government work will be engaged.—Apply, with full particulars, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4560. K 284

Wanted, Capable Mechanical

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Draughtsman Required, for

Special Work with large Controlled Engineers, S.E. London. Must have had experience of estimation of weights; knowledge of foundry practice an advantage. No applicants residing outside radius of ten miles or already employed on Government work can be engaged. Write, stating age, experience and salary required.—Address, K 396, Offices of Engineering.

Draughtsman (Civil and Me-

chanical) WANTED, immediately, for Government Work in London, and on South Coast. Applicants must be ineligible for General Service and should give full particulars of their experience and qualifications, with references or copy of testimonials, and state salary required.—BOX D.W.M.N. 926, Willing's, 125, Strand, W.C. 2. K 423

Wanted, Draughtsmen, for

drawing electrical apparatus in a Government department at Portsmouth. Applicants to have at least two years' experience in a commercial drawing office. Wages, 67s. 6d. (inclusive) per week of 42 hours, plus overtime.—Replies to BOX 914, Willing's, 125, Strand, W.C. 2. K 400

Draughtsmen Wanted for

Power Station Work.—Apply by letter, stating particulars of experience, age and wages required, to the YORKSHIRE ELECTRIC POWER CO., Wellington Road, Dewsbury. K 401

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good experience in design of Steelworks Machinery preferred, although applications from high-class men with other experience would be considered. No one already on Government work will be engaged.—State age, experience and salary required and when at liberty, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4594. K 393

A General Constructive En-

gineering DRAUGHTSMAN REQUIRED in Government Office, London district. Applications from candidates already in Government employment cannot be considered. Must be ineligible for Military Service.—Apply, stating age, experience, salary required, and enclosing copies of three recent testimonials, to BOX 925, Willing's, 125, Strand, W.C. 2. K 406

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Capable Jig and Tool DRAUGHTSMAN, preferably with experience of Motor Vehicle manufacture. London district. No person already on Government work will be engaged.—Apply, stating age, salary and full particulars of experience, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 3229. K 293

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Firm of Electrical Engineers, Government Controlled, in West London district. A fully competent man used to the mechanical design of small motors, dynamos and switches. Only those not already on Government work and residing within a 10-mile radius need apply, and only replies fully stating particulars of experience, and salary, will be considered.—Address, K 292, Offices of Engineering.

Wanted, Experienced

DRAUGHTSMAN, for large controlled establishment, Manchester district. Used to general maintenance work, lay-out of plant, buildings, &c.; also general repair of machines. No one already on Government work will be engaged.—State age, experience and salary required to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4606. K 297

Wanted, Experienced and

Capable Jig and Tool DRAUGHTSMAN.—Apply to your nearest EMPLOYMENT EXCHANGE, mentioning this Journal and K 350. No one an Government work will be engaged. K 350

Draughtsman, Capable, Pre-

ferably with experience of Electrical Control Gear.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4578. No one on Government work should apply. K 348

Experienced Draughtsman

REQUIRED, for Lay-out and Maintenance Department of large Engineering works, London, N.W. Applicants should state age, experience and salary required. No one need apply who lives more than ten miles away or who is engaged on Government work.—Write, BOX, 975, Sell's, Ltd., 168, Fleet Street, E.C. 4. K 349

Wanted, Mechanical

DRAUGHTSMAN.—Apply, stating age, experience and salary required, to ABRAM LYLE AND SONS, Ltd., Sugar Refiners, Plaistow Wharf, Victoria Docks, E. 16. K 351

Wanted, Experienced Jig and

Tool DRAUGHTSMAN, for Government work; West of England. No person already on Government work will be engaged.—Apply, stating age, salary and full particulars of experience, to the nearest EMPLOYMENT EXCHANGE, mentioning this Journal and A 4547. K 249

Wanted, Draughtsman, for

designing condensing and auxiliary plant for land and marine use. Must be ineligible for Army. Only those not on Government work or resident not more than 10 miles away will be engaged.—Write, giving full particulars experience, and salary, to "AIR," care of Street's, 30, Cornhill, E.C. 3. K 340

Good Draughtsman, used to

Conveyor and Structural work, with experience of project work preferred. Must be quick and accurate. No one already on Government work or resident more than ten miles away need apply.—Address, K 360, Offices of Engineering.

Senior Draughtsman Required

for Experimental Engineer's Department, varied work. Good man can reckon on quick promotion. No one already on Government work will be engaged.—Apply, with full details, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4560. K 359

Wanted, Two or Three

Mechanical DRAUGHTSMEN, preferably accustomed to general hydraulic work. No person already on Government work will be engaged.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, mentioning No. A 4579. K 330

Concrete Vessels.—Ship's

DRAUGHTSMAN used to General Arrangement Plans, Piping, &c., REQUIRED. No one on Government work or resident more than 10 miles away will be employed.—Apply, stating age, experience and salary required, to CHRISTIANI AND NIELSEN, 26, Victoria Street, S.W. 1. K 377

An Opportunity occurs in a

large Acton Works for several JIG AND TOOL DRAUGHTSMEN. Must be neat, quick, and have a good knowledge of small accurate work; one must have a good knowledge of Automatic Machines and be capable of laying out "B. & S." Cams.; one will be required, experienced in Power Press work of a small nature. Permanent positions to really capable men. Only those not already on Government work and residing within a 10-mile radius need apply, stating full particulars, age, salary, &c.—Address, K 376, Offices of Engineering.

Draughtsman, Mechanical,

one used to locomotive work preferred.—Apply, stating age, experience and salary required, to your nearest EMPLOYMENT EXCHANGE, quoting No. A 4677. No person already engaged on Government work need apply. K 398

INFLUENCE LINES FOR CONTINUOUS BEAMS.

By G. R. MAGNEL, I.C.C. (Ghent).

IN recent years reinforced concrete has been used so extensively that it has become a matter of vital importance to the designer to be able to take into account the monolithic nature of a ferro-concrete structure without having to spend too much time in long and difficult calculations. In principle it is always possible, by well known text-book methods, to design any structure, even if it is very highly statically indeterminate, as reinforced concrete structures always are; this would, however, take so much time, and need dealing with so many equations, that it cannot be considered as a practical possibility. It follows that in all structures the designer has to make simplifying assumptions, consisting always in supposing that members are independent from others, although in reality they are continuous with them. No one would ever think of taking into account the fact that a load applied on the first floor of a five-storey building creates a bending moment in every beam of the roof, although theoretically this is true. The simplifying assumptions that can be made in practice are rather limited, and the skill of the designer consists in discovering these; other simplifications cannot be introduced without serious practical consequences. So, for instance, it would not do to consider a continuous beam over several supports as a series of simply supported beams. This would be wrong as much from a structural as from an economical point of view. But even in the relatively simple case of a continuous beam, the calculations are very long, particularly where the number of spans is great and where live loads have to be dealt with. A widely accepted practice consists in assuming all the spans to be equal in length and stiffness, as in this simplified case tables and graphs are found in all text-books giving immediately the unknown bending moments. This is, however, unsatisfactory where the spans are very different in length and stiffness.

The writer proposes to explain in the present article how this problem can be solved with theoretical accuracy in a very few minutes.

In order to avoid making this article unnecessarily long, only the bending moments over the supports will be considered, a method being explained to find the influence lines for these points.*

It is well known—and it will moreover be explained below—that the general shape of these lines is as shown on Fig. 1, where the influence line for the B.M. over support S is drawn (see also Fig. 9). For practical purposes it is sufficient to plot the part of this line extending over two spans on each side of the support S, as further from S the ordinates become very small. The table explained below will only give the ordinates in these four spans, although it might easily be extended to give the whole influence line, as will be explained hereafter.

Let L_1, L_2, L_3, ... denote the spans of the beam starting from the left; I_1, I_2, I_3 ..... the corresponding inertia moments, λ_1, λ_2, λ_3, ... the values of

$$\frac{L_1}{I_1}, \frac{L_2}{I_2}, \frac{L_3}{I_3} \ldots\ldots$$

The first operation will consist in filling in Table A, page 164, as follows:—

1. Fill in the values of L and I along the sketch on top of the table; these are given quantities.

2. Calculate the values of λ and write same on the first line.

3. Write on the second line (marked β) the values of the coefficient called β, obtained by

$$\beta_{n+1} = \frac{1}{\frac{\lambda_n}{\lambda_{n+1}}(2-\beta_n)+2}, \quad . \quad . \quad (1)$$

where n denotes a certain span and $n+1$ the next one to the right. The initial value of β being $\beta_1 = 0$, all the following ones are easily calculated.

4. Write on the third line (marked γ) the values of the coefficient called γ, obtained as β, but by starting at the last span to the right where $\gamma = 0$, the formula is

$$\gamma_n = \frac{1}{\frac{\lambda_{n+1}}{\lambda_n}(2-\gamma_{n+1})+2}. \quad . \quad . \quad (2)$$

In filling in Table A no reference has been made to the special support to which the unknown influence line applies; this will only be necessary for Table B, the use of which will now be explained.

Note first the new way of denoting the spans. Those to the right of the support S to which the influence line applies are denoted by L_{+1}, L_{+2} ..., those to the left by L_{-1}, L_{-2}, ...

Table B, page 164, is to be filled in as follows:—

1. Fill in the values of L, I β and γ along the sketch on top of the table by picking the necessary figures out of Table A.

2. Calculate the value called a, equal to

$$a = (2-\beta_{-1})\lambda_{-1} + (2-\gamma_{+1})\lambda_{+1} \quad . \quad (3)$$

3. Calculate the values of the coefficient called K (one for each span) and write them in the second column.

4. The remaining part of the table is composed of eight horizontal lines, marked alternately Y and i in the third column. In each line there is room for nine figures besides the two zeros already marked; each of these nine figures corresponds to a special point of the corresponding span; this is shown by the value of $i = \frac{x}{L}$ written above it as heading; x is the abscissa, as explained in a note at the bottom of the table.

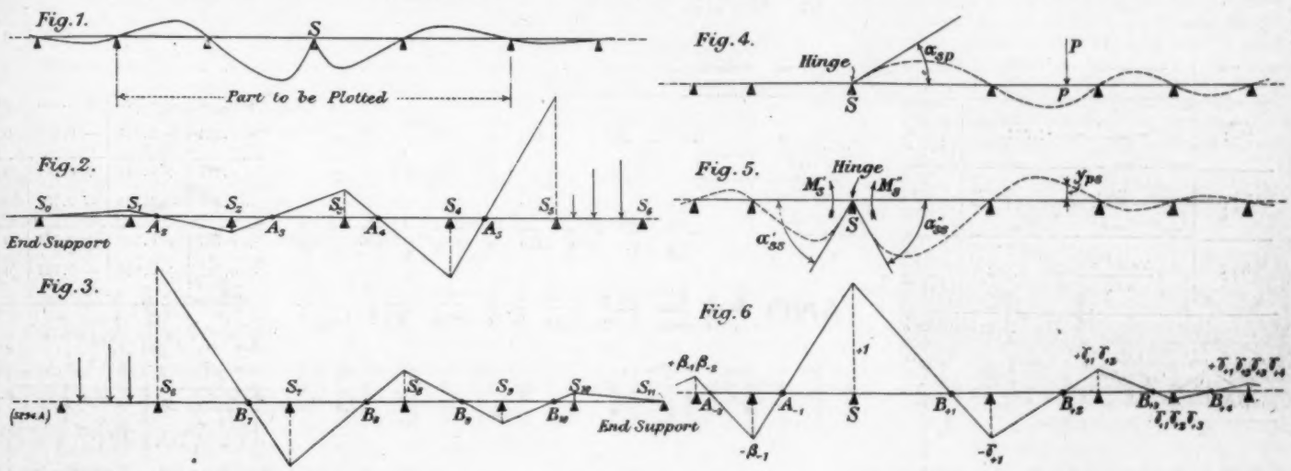
To get the nine figures of one of the four lines marked Y, consult graph, Fig. 10, on which nine sloping lines are seen, each corresponding to a value of i as written along these lines. Take, for instance, the line Y_{-2}; to the value of β_{-2} (written along the sketch on top of the diagram), set out as abscissa on the graph, correspond nine ordinates to each of the nine sloping lines. These ordinates are the figures for line Y_{-2}. For the lines Y_{-1}, Y_{+1}, Y_{+2} of Table B the nine figures are obtained in the same way by setting out as abscissa on the graph the corresponding values of β or γ.

5. If, now, the nine figures of each of the Y lines are multiplied by the corresponding coefficient K, as found in the second column, the products, to be written in the i lines, are the final influence ordinates to be found.

The influence line need now only be plotted as nine equidistant ordinates are known in each of the spans.

If the B.M. influence line for another support than S is wanted, only Table B has to be filled in again, Table A remaining as it is.

Short Theoretical Proof.—If a continuous beam is so loaded that no loads occur in an uninterrupted series of spans starting from the end support to the left, say from S_0 to S_5 (Fig. 2), the B.M. line in these spans has the general shape shown on Fig. 2, the moments over the supports being alternately positive and negative and growing quickly in magnitude from left to right. In between two supports the moment line is straight and crosses the reference



line at points A_2, A_3, A_4 and A_5, which are always the same, whatever the loading of the beam may be outside the series of unloaded spans. These points divide the spans in two parts, the ratios of which are denoted by β, so that

$$\beta_2 = \frac{S_1 A_2}{S_2 A_2}, \beta_3 = \frac{S_2 A_3}{S_3 A_3} \ldots .$$

The values of this coefficient β are given by formula (1) above. This is a well known fact, recorded in all the text-books, and consequently there is no need to dwell upon it here.

Similarly, if the uninterrupted series of spans starts at the end support to the right, say from S_{11} to S_6 (Fig. 3) the B.M. line is as shown on Fig. 3, the points B being always the same, although not the same as points A; they divide the spans in two parts, the ratios of which are denoted by γ, so that

$$\gamma_{10} = \frac{S_{10} B_{10}}{S_9 B_{10}}, \gamma_9 = \frac{S_9 B_9}{S_8 B_9}, \ldots .$$

The values of this coefficient γ are given by formula (2) above.

It is obvious from Figs. 2 and 3 that $\beta_1 = 0$ and $\gamma_{11} = 0$. Table A explained above gives the values of β and γ.

Let it further be shown how a simple view can be obtained of the moment influence line for a certain intermediate support S.

For the sake of argument let a hinge be introduced at S. If, then, a load P is applied to any point p the beam will deflect as shown on Fig. 4, giving at S an angular deflection $\alpha_{s\,p}$, the indices denoting that it is a deflection at S due to P. In order to give a sign to this angle it will be agreed to consider it as positive if it is the result of the first element of the beam to the right of S turning

* The writer will not insist again on the use and definition of influence lines, but will refer the reader to two of his recent articles. See ENGINEERING, April 27, 1917, page 391, and "*Concrete and Constructional Engineering*," vol. xii, Nos. 10 and 11, page 560, 1917.

TABLE A_1.

L= 10' 20' S 15' 12' 12' 15'

I= (5337.A) 2 4 2 2 2 1·5

λ	5	5	7.5	6	6	10						
β	0	0.250	0.316	0.24	0.266	—						
γ	—	0.220	0.295	0.262	0.187	0						

Note.—If convenient the values of I may be taken as 10, or 100, or any times their real values.

$$\lambda = \frac{L}{I} \qquad \beta_{n+1} = \frac{1}{\frac{\lambda_n}{\lambda_{n+1}}(2-\beta_n)+2} \qquad \gamma_n = \frac{1}{\frac{\lambda_{n+1}}{\lambda_n}(2-\gamma_{n+1})+}$$

TABLE B_1.

$a = (2-\beta_{-1})\lambda_{-1} + (2-\gamma_{+1})\lambda_{+1} = 21.54.$

$\beta_{-2} = .0$ $\beta_{-1} = .250$ $\gamma_{+1} = .295$ $\gamma_{+2} = .262$

$L_{-2} = 10$ $L_{-1} = 20$ S $L_{+1} = 15$ $L_{+2} = 12$

(5337.B) $I_{-2} = 2$ $I_{-1} = 4$ $I_{+1} = 2$ $I_{+2} = 2$

Span.	Factor K.	—	Values of Y and i for Different Values of $\frac{x}{L}$ (see Note).										
		$\frac{x}{L}$ =	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
L_{-2}	$\frac{\beta_{-1}L^2_{-2}}{a I_{-2}} = +0.580$	Y_{-2}	0	+ 0.099	+ 0.192	+ 0.273	+ 0.336	+ 0.375	+ 0.384	+ 0.357	+ 0.288	+ 0.171	0
		$i_{-2} = K_{-2} Y_{-2}$	0	+ 0.057	+ 0.111	+ 0.158	+ 0.195	+ 0.217	+ 0.223	+ 0.207	+ 0.167	+ 0.099	0
L_{-1}	$-\frac{L^2_{-1}}{a I_{-1}} = -4.642$	Y_{-1}	0	+ 0.056	+ 0.120	+ 0.183	+ 0.240	+ 0.281	+ 0.300	+ 0.289	+ 0.240	+ 0.146	0
		$i_{-1} = K_{-1} Y_{-1}$	0	− 0.260	− 0.557	− 0.850	− 1.115	− 1.307	− 1.393	− 1.344	− 1.115	− 0.678	0
L_{+1}	$-\frac{L^2_{+1}}{a I_{+1}} = -5.223$	Y_{+1}	0	+ 0.048	+ 0.107	+ 0.168	+ 0.222	+ 0.264	+ 0.285	+ 0.277	+ 0.231	+ 0.141	0
		$i_{+1} = K_{+1} Y_{+1}$	0	− 0.251	− 0.559	− 0.878	− 1.158	− 1.377	− 1.488	− 1.445	− 1.205	− 0.737	0
L_{+2}	$\frac{\gamma_{+1}L^2_{+2}}{a I_{+2}} = +0.986$	Y_{+2}	0	+ 0.053	+ 0.117	+ 0.179	+ 0.234	+ 0.276	+ 0.296	+ 0.285	+ 0.238	+ 0.144	0
		$i_{+2} = K_{+2} Y_{+2}$	0	+ 0.052	+ 0.115	+ 0.177	+ 0.231	+ 0.272	+ 0.292	+ 0.281	+ 0.235	+ 0.142	0

Note.—Origin of x at left end of span for spans L_{-1} and L_{-2}; at right end of span for L_{+1} and L_{+2}.

Fig.7.

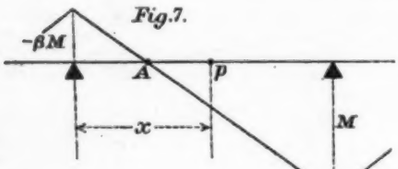


Fig.8.

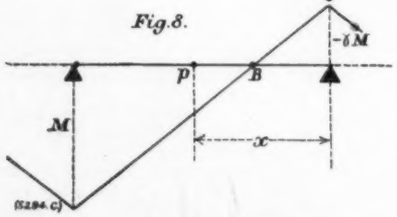
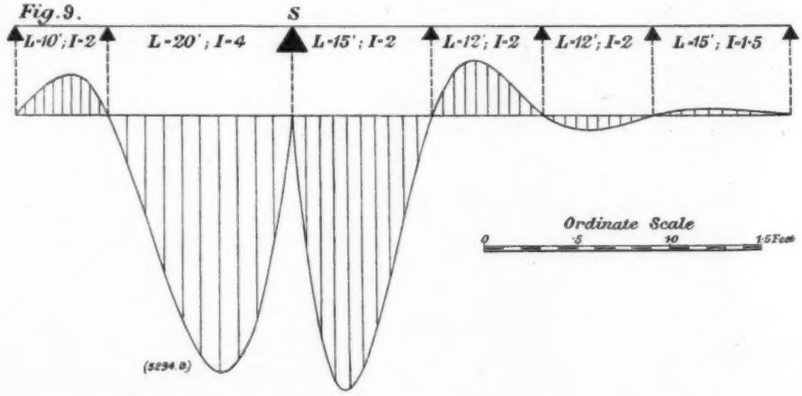


Fig.9.



in the direction of what is generally considered as a positive moment applied to that element; consequently $a_{s\,p}$ is negative in the case of Fig. 4.

If, on the other hand (Fig. 5), two equal but opposite moments M'_s and M''_s (of common magnitude M_s) are applied, one to the first element to the left of S, the other to the first element to the right, both being in the direction of a positive moment applied to these respective elements, the beam deflects, as shown on Fig. 5, the angular deflections to the left and to the right being respectively $\alpha'_{s\,s}$ and $\alpha''_{s\,s}$ (both positive values) giving a total angle, between right and left element of $a_{s\,s} = \alpha'_{s\,s} + \alpha''_{s\,s}$ indices denoting a deflection at S due to a moment acting at S). At the same time the deflection at point p will be $y_{p\,s}$ (at p due to S); this will be considered as positive if it means a lowering of point p.

If, now, to the real beam without hinge, a force P is applied at p, a certain moment M_s is automatically brought in existence at S, so that this real beam may in fact be considered as the hinged beam to which two loadings are applied simultaneously; the one is P and the other a couple of equal and opposite moments M'_s and M''_s of common value M_s. This latter value M_s depends, of course, upon the value of P and is determined by the fact that the combination of the two loadings P and M_s leaves the element to the right of S absolutely in line with the element to the left, without any angular deflection between them. In other words, the value of M_s corresponding to P is determined by the equation

$$a_{s\,p} + a_{s\,s} = 0 \quad . \quad . \quad . \quad . \quad (4)$$

Now, in virtue of Maxwell's famous reciprocity theorem,

$$\frac{a_{s\,p}}{P} = \frac{y_{p\,s}}{M_s} \text{ or } a_{s\,p} = \frac{P}{M_s} y_{p\,s},$$

which, substituted in (4), gives

$$M_s = -\frac{y_{p\,s}}{a_{s\,s}} P.$$

It follows therefore that the influence line ordinate i at p—which is the value of the bending moment M_s when P = 1 — is given by

$$i = -\frac{y_{p\,s}}{a_{s\,s}} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The numerator and denominator of i are both deflections of the hinged beam loaded by $M'_s = M''_s = M_s$, as shown on Fig. 5; but i itself does not therefore depend upon the magnitude of M_s, as both numerator and denominator are proportionate to M_s. So that i may be calculated by applying to the hinged beam any moment M_s, say, for instance, $M_s = 1$. As now the denominator is a constant not depending upon the special value of x considered, it is seen that the influence line is, on a certain scale, the deflection line of the beam, as shown in Fig. 5; the deflections $y_{p\,s}$ need only be divided by $a_{s\,s}$ to give the real influence ordinates.*

* This is a general theorem of which one example only is explained here; it is very useful in all statically indeterminate structures.

This will make it easy to find the influence line of the moment M_s. Indeed, in virtue of the property explained above concerning the fixity of the points A and B, the moment line in the hinged beam loaded as in Fig. 5 is completely known, as shown on Fig. 6. Consequently, it is a very simple matter to find the deflections of this beam; it will even be sufficient to calculate these deflections for one span as the B.M. line has the same general shape in all the spans.

If, for instance, any span at the left of S is considered, the moments are as shown on Fig. 7, and by applying the simple theory of deflections of straight beams, it is found that

$$y_{p\,s} = \frac{M\,L^2}{6\,E\,I}\left[t - t^3 + (3\,t^2 - t^3 - 2\,t)\,\beta\right] \quad . \quad (6)$$

M being the moment shown on Fig. 7, I the inertia moment of the span in question, and $t = \frac{x}{L}$, the origin of x being the left-hand support of the span.

The angular deflection $a'_{s\,s}$ (part of $a_{s\,s}$) is found by applying the deflection formula to the span situated immediately to the left of S, in which $M = 1$; this gives

$$a'_{s\,s} = (2 - \beta_{-1})\frac{\lambda_{-1}}{6\,E} \quad . \quad . \quad . \quad (7)$$

If a span situated at the right of S is considered, as in Fig. 8, the formulae corresponding to (6) and (7) are

$$y_{p\,s} = \frac{M\,L^2}{6\,E\,I}\left[t - t^3 + (3\,t^2 - t^3 - 2\,t)\,\gamma\right] \quad . \quad (8)$$

(where $t = \frac{x}{L}$, the origin of x being the right hand support of the span), and

$$a''_{s\,s} = \left(2 - \gamma_{+1}\right)\frac{\lambda_{+1}}{6\,E} \quad . \quad . \quad (9)$$

By adding (7) and (9) the value of $a_{s\,s}$ is found; the coefficient a given by formula (3) is equal to

$$a = 6\,E\,a_{s\,s}.$$

In virtue of (6) and (8) equation (5) becomes

$$i = K\,Y, \quad . \quad . \quad . \quad (10)$$

where

$$K = -\frac{M\,L^2}{I\,a} \quad . \quad . \quad (11)$$

and

$$Y = t - t^3 + (3\,t^2 - t^3 - 2\,t)\,\beta \quad . \quad . \quad (12)$$

for the spans at the left of S, and

$$Y = t - t^3 + (3\,t^2 - t^3 - 2\,t)\,\gamma \quad . \quad . \quad (13)$$

for the spans at the right of S.

Table B is a direct application of formulae (10) and (11), whereas Graph Fig. 10 corresponds to the formulae (12) and (13).

The area of the part of the influence line over a certain span is given by

$$a = \frac{1-\beta}{4}\,K\,L, \text{ or } a = \frac{1-\gamma}{4}\,K\,L$$

obtained by integrating equation (10).

If a uniformly distributed load q covers the span in question, the corresponding B.M. over support S is

$$M_s = q\,a.$$

It will easily be seen how Table B might be extended both at top and bottom so as to give the complete influence line in all the spans. The only difficulty consists in the extension of the second column giving K.

The extended values of K are

$$K_{-3} = -\frac{\beta_{-1}\,\beta_{-2}\,L^2_{-3}}{a\,I_{-3}}, \qquad K_{+3} = -\frac{\gamma_{+1}\,\gamma_{+2}\,L^2_{+3}}{a\,I_{+3}},$$

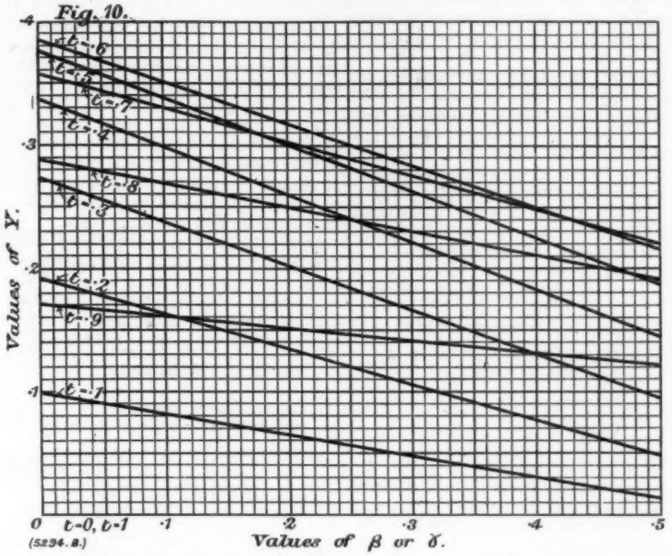
$$K_{-4} = +\frac{\beta_{-1}\,\beta_{-2}\,\beta_{-3}\,L^2_{-4}}{a\,I_{-4}}, \qquad K_{+4} = +\frac{\gamma_{+1}\,\gamma_{+2}\,\gamma_{+3}\,L^2_{+4}}{a\,I_{+4}},$$

. . . . . .

This extension is, however, hardly ever necessary in practice.

An example of the method explained in the present article has been worked out in Tables marked A_1 and B_1, and the corresponding influence line is shown on Fig. 9.

Fig. 10.



(5294. a.)

THE ECONOMICS OF THE CHINESE RAILWAYS.

(*Concluded from page* 141.)

WITH regard to the question of constructional economics it would seem that something might be done by varying the present standards. At present these call for 1,000 ft. radius curves, 1 in 100 grades, and 85-lb. rails. These regulations in mountainous country have been very wisely departed from with the sanction of the Government. Thus, in the Peking-Kalgan Railway (No. 8) 1 in 30 grades and 500 ft. curves were permitted. In spite of these high limits the line had over a mile of tunnels, deviation from the present route at a later date is, therefore, impossible without abandoning an enormously costly line. It is difficult to believe that a more non-committal route could not have been found in view of the limits of grade and curvature allowed.

These high limits are undoubted wise if a light line can be built, and such expensive things as tunnels avoided, for even in China dry tunnels in rock cost 10*l.* per foot. As things are, on this particular line, the Government is absolutely committed to a line which one day may be of vast importance, on which goods trains have to be halved to get over the heavy grades on which Mallet and geared locomotives are employed. The running expenses per train mile are consequently about twice those on the line with 1 in 100 grades, being 5*s.* 4*d.* against 2*s.* 9*d.*, 2*s.* 10*d.* and 3*s.* 1½*d.* on the Peking–Hankow, Tientsin–Pukow and Peking Mukdon Railways. The line in spite of this even now pays handsomely, but there is no doubt that the Government will be faced with enormous expense in the future if the line extends as shown on the map, page 84 *ante*.

The effect of the heavy grades on the Kalgan line is as follows. The mountain section is about 40 miles long and the total length of the line 150 miles. The effect of this heavy section is to increase the train mileage by 40 miles per train as each must be halved over this section, or by 25 per cent. approximately. The present annual train mileage is about 428,000 of which one quarter or 107,000 is extra due to heavy grades. This extra mileage at 5*s.* 4*d.* per train mile costs 28,600*l.* per annum. Foreign money at a cost to China of 13 per cent. including finance would justify an immediate expenditure of 220,000*l.* for grade improvement. This is stating the case mildly as it neglects the very great saving in running expenses due to improved grades.

It would appear to be wise to permit limits of grades and curvature of 1 in 40 and 330 ft. on even important lines in heavy country, but it should be a *sine qua non* that the construction on these portions should be of a character admitting of drastic deviation of the route without much loss. Bridges should be of trestle type or perhaps of ashlar in lime mortar or rubble in cement in places where stone is plentiful. For culverts reinforced concrete pipes should be used, the culverts being contoured wherever possible to save length, as has been successfully done in India and tropical Africa. Back shunts should be permitted to avoid tunnels, and the utmost use made of assistant engines over these heavy sections.

The cost of working assistant engines may be estimated as an additional tax per train mile, over the section entailing their use of

1*s.* 10*d.* per engine-mile on 1 in 30 grades, 300-ton train.
2*s.* 1*d.* per engine-mile, on 1 in 50 grades, 500-ton train.

This rests on the assumption that the assistant engine will do a full day's work of 100 engine miles, which only means five round trips on a 10-mile section. The effect of the assistant engine is to double the motive power, thus converting 1 in 50 into the 1 in 100 and the 1 in 30 to 1 in 60. There is, of course, a limit of length of line depending on total daily train mileage at which assistant engines cease to be economical. Take the case in which the amount of 1 in 50 gradient is 10 miles in length. It is obvious that an assistant engine ceases to be economical when the extra cost of the engine per train mile equals the cost per train mile. On such a line as the above where the limiting grade is 1 in 100, except in these places where difficult country is encountered and where assistant engines are employed, traffic should cost about 3*s.* per train mile. Thus, if the line is L miles in length and five trains per day are run, the limit at which assistant engines cease to be economical is given by the equation $5 \times L \times 36$ equals 2,500 pence or the cost per day of the assistant engine, or L equal 14 miles.

If only two trains per day are run the daily cost of the engine is much reduced, as in a 10-hour day the engine would be five hours standing in steam, burning perhaps 40 lb. of coal per hour or 200 lb. altogether, costing about 1*s.* 2*d.* The total daily cost of the assistant engine would then be as follows:—

Standing charges as before, driver and two firemen	0	4	5
Interest at the rate of 20 per cent. per annum on 6,000*l.* (cost of two locomotives and housing) to cover interest, depreciation and maintenance	3	6	8
Total standing charges ...	3	11	1
	(or 853 pence)		
Coal standing in steam Coal at 11*s.* 8*d.* per ton = 14*d.*			
Coal running 40 engine-miles, each round trip (equivalent to 25 miles of gradient) ... 85 lb. coal per mile = 425*d.*			

Total daily cost of extra engine, 1,292 pence.

In this case the limit L is given by the equation—

$$2 \times L \times 36 = 1{,}292.$$
$$L = 18 \text{ miles.}$$

It will be seen from the above that if as much as 50 per cent. of a 25 mile sections is 1 in 50, and the remainder 1 in 100 or less then it pays to run assistant engines in China even if only two trains

per day are run. These figures seem to indicate that a more extended use of assistant engines might be advisable and also the sound economics of high maximum gradients where difficult country is encountered, provided that construction of a cheap and non-committal character is feasible. Thus on a line 600 miles in length the additional cost per train mile of working 10 miles of 1 in 50 grade with two trains per day is only one penny per train mile, and, of course, less if more trains are run. By the adoption of this grade the capital saving on this 10 miles is 60,000*l.* (the difference between 10,000*l.* per mile and 4,000*l.* per mile) constituting an additional charge per mile of 6*l.* per year at 6 per cent. interest on a 600-mile length of line. This is equivalent to 3.95 pence per mile per day, or 2 pence per train mile for two trains per day.

The traffic is worked at an additional cost of one penny per train mile over the 1 in 50 section, with assistant engine so that with two trains a day a saving of one penny per train mile results from the adoption of the 1 in 50 grade. Moreover, a railway line of similar capacity has been provided barring the slight speed restriction which would result from this length of heavy grade.

With reference to limits of curvature the 330 ft. curve should certainly be adopted as a minimum, as it offers no restriction as to weight and build of engine and is safe for speeds of 35 miles an hour. Another economy resulting from variation of standards would be the use of the 60-lb. rail instead of the 85-lb. for important lines.

The difference in cost per mile is as below :—

85-lb. Rail	£	60-lb. Rail.	£
156 tons steel at 8*l.*	1,248	112 tons steel at 8*l.*	896
900 fang ballast (8 in. under) ...	450	700 fang ballast (6 in. under) ...	350
100 miles carriage on ballast, 3*s.* 4*d.*, in trucks at quarry.			
2,488 sleepers (14 to 30 ft. rail) ...	358	2,112 sleepers (12 to 30 ft. rail) ...	300
Total cost per mile	2,056	Total cost per mile	1,546

This results in a saving per mile of 510*l.* or about 550*l.* of capital, paying interest since pre-war finance cost China about 8 per cent. This constitutes an additional tax at 6 per cent. per annum of 33*l.* per mile or 22 pence per day per mile. Now on the assumption of similar costs per train mile and axle loads proportional to rail weight, if the cost per ton mile hauled on the 85-lb. rail is 1 cent, that on the 60-lb. rail should be 1.42 cents resulting in a difference per ton mile of 0.42 cents. On the Chinese Railways however the permissible axle loads on the two rails are 16 and 13 tons, so that the cost per ton mile on the 60-lb. rail should be 1.22 cents or a saving of .22 cents per ton for 85-lb. rail. This, however, neglects the difference in coal consumption for the heavier trains on the 85-lb. rail, but this saving of 0.22 cents per ton implies that at least 500 tons of paying load must pass every day over each mile of the 85-lb. track in order to pay the extra cost of the 85-lb. rail. It is a question whether any of the railways in China have this density of traffic with the exception of the Peking–Mukden (No. 5) Railway 60 per cent. of whose goods traffic is coal.

This line has only about 267 miles of 85-lb. rail out of a total of 607 miles, the remainder being 60-lb. rail, but it has traffic density of 1,680 tons per mile per day. Mineral trains on the Peking–Mukden Railway average 100 axles on the 85-lb. rail or 600 tons of paying load per train, so that lines with a very large mineral traffic can easily afford an 85-lb. rail, but the 60-lb rail and the use of eight-coupled engines would provide all that was needed in most cases for many years. For instance, the Peking–Mukden after nearly 30 years has only recently found the 85-lb. rail a partial necessity.

In addition no maintenance economy results from the heavier rail. Maintenance labour on the Peking–Mukden (No. 5) Railway most of which (56 per cent.) is 60-lb. rail has become standard all over China irrespective of rail weight. The cost of this is about 35*l.* per mile per annum in North China, working out at about three men per mile. The rainfall in the South is greater than in the North, but the lines are better ballasted. Further, as pointed out above, the 85-lb. rail is not worked up to its full carrying capacity of 20 tons axle loads, the majority of the engines having only 16 ton axle loads.

It is very doubtful whether much economy would result from the adoption of another form of sleeper for the present untreated Japanese oak sleeper costing at present 2*s.* 4*d.* ($1.43) each. This sleeper has a life of about eight years in well ballasted roads north of the Yangtze River. South of this the Jarrah sleeper has been adopted in most cases at a cost of 7*s.* 6*d.* ($4.50) each as the Japanese sleeper is said to only last five years. The life of the Jarrah sleeper expected is 20 years, but no railway using them has been operating for that length of time so no statistics are available, but Indian experience seems to indicate a life of not more than 15 years. The figures below indicate that if 25 years can be got out of the Jarrah sleeper then the Japanese sleeper with a life of five years is slightly dearer, while if only 20 years is obtained the Japanese sleeper is the cheaper investment. The following table shows this comparison :—

Sleeper.	Total Value of Capital Invested at 5 per cent. Compound Interest.	£	*s.*	*d.*
Jarrah ...	20 years' life ...	0	18	5
Japanese ...	4 sleepers, 5 years' life	0	17	0
Jarrah ...	25 years' life ...	1	4	2
Japanese ...	5 sleepers, 5 years' life	1	7	2

Then for those railways already ballasted the present use of the Japanese sleeper is undoubtedly sound policy, provided that prices do not rise and that the quality does not deteriorate, which it is at present inclined to do.

The following table shown the comparison for the cast iron pot sleeper as used on the Indian Railways :

	Total Value of Capital Invested.	£	*s.*	*d.*
Cast-iron pot sleeper, weight 220 lb. ...	60 years' life	19	10	0
2 pressed steel sleepers—weight 140 lb.	30 „	13	15	0
3 Jarrah sleepers, as above	20 „	10	2	0
7½ Japanese sleepers ...	8 „	6	4	0
12 Japanese sleepers ...	5 „	9	0	0

So that the pot sleeper is undoubtedly too expensive for these roads already committed to ballast. Its adoption would also entail new training for the Chinese platelayer, as pot sleepers have never been tried in the country. The pot sleeper at the present price of 1.2 pence per pound has no chance of adoption in spite of the fact that rock ballast is not a necessity for its use. It is believed that the pressed steel sleeper has on the contrary a great future before it in this country unless China takes steps in the directions of re-afforestation and conservation of her present neglected forests. Japanese timber cannot go on supplying timber for a much greater mileage of railways than it does at present, and as pointed out above, the quality is by no means what it was. In what follows it will be assumed that pressed steel sleepers can be produced at 10*l.* per ton. This is an extravagant assumption, for if China developed her steel industry properly these sleepers could be produced for at least half this amount, but at any rate it is not open to the charge of being too sanguine an estimate. The following is a comparison for the steel sleeper :—

	Capital Invested.	£	*s.*	*d.*
1 steel sleeper—weight 140 lb. for 85-lb. rail	30 years' life	2	10	0
1½ Jarrah sleeper ...	20 „	2	2	0
6 Japanese sleeper ...	5 „	1	15	0
1 steel sleeper—weight 100 lb. for 60-lb. rail	30 „	1	18	7

On this basis the steel sleeper has at present no chance, but the following table is of interest as showing the limit to which the price of the Japanese sleeper may rise in order to make the introduction of the steel sleeper a paying policy.

Sleeper.	Expected Life.	Limit of Price, Japanese Sleeper.
140 lb. steel	30 years	3*s.* 6*d.* for 5 years' life. S. China.
140 „	30 „	5*s.* for 8 years' life. N. China.
100 „	30 „	2*s.* 6*d.* for 5 years' life. S. China.
100 „	30 „	3*s.* 6*d.* for 8 years' life. N. China.

The present price of the Japanese sleeper is 2*s.* 4*d.*, so that on the above figures a rise of only two pence would make the introduction of the steel sleeper for 60-lb. rail in South China sound policy. The initial prices of the two steel sleepers are 12*s.* 6*d.* and 8*s.* 11*d.* each. Moreover the steel sleeper is known to have a life of at least 30 years, so that the case for it is underestimated if anything. It should be pointed out, however, that in salt or alkali impregnated soils its life is very short, namely, from five to seven years.

If the steel sleeper was adopted as standard for new lines on the plain, rock ballast would not be required, with a resultant saving of 450*l.* per mile to put against the extra cost of steel sleepers. With 1,800 steel sleepers to the mile the costs of the two types of track would be as follows :—

85-lb. Rail.	£	
Rails as before	1,248	
Steel sleepers ...	1,122	Weight, 140 lb.
Cost per mile	2,370	(Against 2,506*l.* for timber sleepers.
60-lb. Rail.		
Rails as before	996	
Steel sleepers	805	Weight, 100 lb.
Cost per mile	1,701	(Against 1,546*l.* for timber sleepers.)

From this it is obvious that the steel sleeper would at present be too costly, and in all probability some additional expense would have to be incurred for carriage of proper ballast for steel sleepers, sand or gravel, as it is very doubtful whether a mud lift with material from the borrow pits would carry a minimum traffic of four trains per day, in a district with a rainfall varying from 30 to 60 ins. per annum.

It is of some interest to compare practice on the Rhodesian Railways with that in China. Rhodesia has a wet season much more prolonged than that of China, but the same total annual rainfall as in South China.

These lines are of 3-ft. 6-in. gauge, have steel sleepered 60-lb. track with a mud boxing instead of ballast. They were built at a cost of 4,500*l.* per mile (average). In 1911, on a system of 1,392 miles 1,383,736 train miles were run at a cost of 5*s.* 4*d.* per train mile. This works out at rather more than two trains per day over the whole system. The cost of maintenance is about 45*l.* per mile, and of this practically the whole is labour. White gangers get at least 1*l.* per day, and nigger platelayers, not nearly so efficient or intelligent as Chinese, half-a-crown per day. It might, therefore, be expected that with more efficient labour at about one-sixth of the cost a great reduction in maintenance labour would result from the introduction of steel sleepers in China. A saving in 10*l.* per year on the present labour cost of 35*l.* to 40*l.* per mile would more than justify the extra capital cost of steel sleepers. A saving of 1*l.* per mile would result from the abolition of spike renewals alone.

Further excellent ballast for steel sleepers abounds all over North China and should not cost more than six pence per fang of 100 cub. ft. against 3*s.* 4*d.* paid for rock ballast in cars at the quarry.

These conclusions are borne out by experience in France, where the introduction of the steel sleeper reduced maintenance labour from 24*l.* to 16*l.* per mile. Similar results were experienced in Holland and on the Mexican Southern Railway, where maintenance was reduced 50 per cent. on the introduction of steel sleepers, and this on a line with 4 per cent. grades and 17 degrees curves. At present there is only one railway (of standard gauge) in China with steel sleepers, the German-built Shantung Railway, the track for which cost 2,670*l.* per mile. The working expenses of this line in 1912 were 432*l.* per mile, a figure not indicating any great economy, but the Germans in this country have proved themselves notoriously expensive both in

the management and construction of their own and other railways, so that steel sleepers cannot be said to have been really tried in China. It should be also noted as an instance of the very extended use of steel sleepers even in countries where climatic conditions or white ant have not compelled their use, that there are on the Continent 12,000, and in the Argentine 3,000, miles of steel sleepered track. These railways on the Continent using steel sleepers carry a moderate traffic of about 14 daily trains and are gravel ballasted, while these in the Argentine are not ballasted at all in many cases.

From the above it is sufficiently obvious that there is even now a considerable case for the adoption of the steel sleeper in China.

Another slight economy would result from the adoption of a longer rail than 30 ft. With the flat curvature in the district of the Plain rails of practically any length could be used without bending, running would be smoother and a considerable saving in fish-plates and bolts would result. These fastenings cost nearly twice as much as rails per ton. Thus in the case of a 40-ft. rail instead of a 30-ft. for an 85-lb. rail a saving of 3 tons per mile is effected in fish plates and bolts, implying an economy of about 40*l.* per mile. In the United States and England heavy rails (85 lb. and upwards) from 45 to 60 ft. in length have been found satisfactory, while a 33-ft. rail can be used on a 5-chain curve without bending. This last for a 60-lb. rail.

At present the only steel-works in China can only roll rails 30 ft. in length. As a closing remark in connection with track, the most obvious policy for the Chinese Government is to at once make the greatest efforts to develop the steel industry, as there is very little doubt that pre-war prices for steel will be a long time coming back. China has the nucleus of a great steel industry at Hanyang, near Hankow. Unfortunately this works, which are said to be capable of producing 15,000 tons of pig-iron, and 7,000 tons of steel rails per month, are very largely mortgaged to the Japanese, who have an agreement stipulating that they shall not become a Government concern. The actual output of the works in 1914 was only 135,000 tons of pig-iron and 98,536 tons of steel, so that the works are not worked up to their full capacity as they ought to be. The immediate reorganisation of the steel industry is a national necessity, for China with her cheap skilled labour should be able to produce the cheapest steel in the world.

As a summary of this discussion on variation in standards the most desirable variations appear to be introduction of the following: 60-lb. rail for main line; 40-lb. rail for feeder lines; 5 chain curves and 1 in 50 grades in difficult country, but no work of a very permanent nature permissible in these districts, so that deviation when warranted may be effected at small loss.

With regard to constructional economics, very little can be done in this direction, but as has been pointed out in a previous article there is some case for the more extended use of machinery on railway construction. Portable petrol-driven concrete mixers and steam pile-drivers on large bridges would undoubtedly pay as would also crushers in quarries.

The importation of timber in log instead of partly in plank would also be economical, especially if circular saws were introduced for cutting.

Economy would also result from a more extended use of reinforced concrete, using old rails as reinforcement, for all minor bridges up to 30 ft. span. Not only is the first cost of this type of work less, but the heavy maintenance charges on all paint work in China are avoided. Girder trollies for fixing 20 and 30 ft. spans, as is already done for the 60 ft. steel spans, would result in economy as the only span which can be quickly handled with ordinary tackle is the 12-ft. span. The 20 and 30 ft. standard steel spans weigh 4 and 8 tons approximately, and are very clumsy things to handle without cranes, and if sent out in halves much time is wasted in rivetting up. A girder trolley could easily be built as an ordinary extra long bogie wagon with platforms at each end for the winches. The trolley with the suspended girder all rivetted up could then be sent out from the erecting yard run out over the bridge on a temporary rail and sleeper stack bridge and lowered direct into position. On the completion of the job all the material in the trolley could be re-utilised. It should be noted that throughout this article the rate of exchange from dollars to sterling has been 5 cents to a penny or 12 dollars to the pound.

The author is indebted to Mr. W. O. Leitch, M.Inst.C.E., for permission to make use of the map given on page 84 *ante*. The numbers placed on the various railways on the map have been referred to in the present article.

THE BRITISH SPELTER INDUSTRY.

WE are now in the fourth year of the greatest conflict in history. The metallurgist and engineer have played a very important part in the prosecution of the war, and their labour has been crowned with much success. Our attention must now, without any delay, and with the same vigour, be directed to a great struggle, i.e., "the war after the war." Our problems are many, and all our best efforts must be put forward to equip ourselves for the coming struggle, which will chiefly fall upon the metallurgist and engineer, supported by chemical research, and last, but not least, the capitalists. One of the important problems before us is the production of spelter in the United Kingdom. Everyone is familiar with its utility and the part it has played in this war, therefore we will exclude this topic and discuss its production in the United Kingdom. But before attempting this it is essential to introduce the following figures, obtained from the "Annual Statement of the Trade of the United Kingdom with Foreign Countries and British Possessions for 1915," compared with the four preceding years:—

Imports.

	1911. Tons.	1912. Tons.	1914. Tons.	1915. Tons.
Zinc, grade	115,232	137,268	145,664	74,522

Exports.

	1911. Tons.	1912. Tons.	1914. Tons.	1915. Tons.
Zinc, crude	7,924	8,584	9,496	767

Approximate production in United Kingdom.

	1914. Tons.	1916. Tons.
Zinc	55,000	60,000

Our production in 1915 would show a slight decrease as compared with that of 1914, owing to the absence of rich zinc-bearing smelting material, such as galvanisers' waste, dross, &c. In 1916 a portion of the extensions effected to some of the spelter works would be in commission. These extensions could not materially increase the production, because they had to smelt low-grade ores in the absence of the rich zinc-bearing smelting material already mentioned. When all these extensions are completed and in operation we shall be able to produce approximately 80,000 tons of spelter per annum.

We were consumers of about 180,000 tons per annum in pre-war days, and in all probability our requirements will be equal, if not greater, when the reconstruction will commence; and we may ask, Where are we to look for this enormous quantity?

In 1913 Germany supplied us with 64,179 tons. In the same year we imported from Belgium 53,500 tons, and from France 5,915 tons. In future the German supplies will be struck off the list. The Belgian supply will take a considerable time to regenerate, as also will the French, and in all probability the Germans will convert Belgium into a scrap heap as they retire. Consequently we are forced to equip ourselves with the necessary plant to produce at least 100,000 tons per annum to meet the demand of the United Kingdom alone. In the absence of the German, Belgian and French supplies the United States of America have supplied us with 35,068 tons in 1914 and 46,276 tons in 1915, as compared with 7,586 in 1911, 4,915 in 1912, and 4,670 tons in 1913.

It will be observed that our position with reference to spelter is very serious. Our mineral resources of this precious metal must be developed. Our production of zinc ores from mines in the United Kingdom for past years are given below:—

1881: Zinc ore produced, 36,440 tons. Average price of spelter per ton, 16*l.* 18*s.*
1882: Zinc ore produced, 32,539 tons. Average price of spelter per ton, 17*l.* 15*s.* 6*d.*
1883: Zinc ore produced, 20,728 tons. Average price of spelter per ton, 16*l.* 1*s.*
1884 till 1908: Average zinc ore produced per annum, 25,000 tons. Average price of spelter per ton, 20*l.* 3*s.* 6*d.*
1909: Zinc ore produced, 9,902 tons. Average price of spelter per ton, 22*l.* 16*s.* 6*d.*
1910: Zinc ore produced, 12,238 tons. Average price of spelter per ton, 23*l.* 19*s.*
1911: Zinc ore produced, 17,652 tons. Average price of spelter per ton, 25*l.* 3*s.* 9*d.*
1912: Zinc ore produced, 17,704 tons. Average price of spelter per ton, 26*l.* 3*s.* 4*d.*

We exported to Belgium in 1912 10,729 tons, and to Germany 417 tons.

We are further given to understand that the output of concentrates from the Broken Hill mines of Australia is 450,000 tons per annum, 40 per cent. of which is to be treated in Australia. This is equivalent to 180,000 tons. There remain 270,000 tons, of which the British Government has contracted to take a minimum of 100,000 tons. Were there sufficient plant in the country, the Government would have no hesitation in contracting for the remaining 170,000 tons, which would yield annually 100,000 tons of spelter. This quantity, together with our enhanced production, would bring our figure near to our pre-war requirements. We assume, therefore, that there are three or four spelter smelters in this country capable of treating the 100,000 tons which the Government has contracted for. Therefore we are still in need of at least five other similar works to smelt the remaining 170,000 tons of concentrates still available in Australia to fulfil the demands of the home markets.

There are in the United Kingdom to-day nine or ten spelter smelters. The smallest is capable of treating 10 tons of ore per day. Each of these firms has been busy extending since 1914. Messrs. Brand's Pure Smelter Company, Limited, Glasgow, has installed 11 new distillation furnaces, bringing the total number of furnaces to 14, altogether containing 2,680 retorts. In 1914 this enterprising firm only had 720 retorts in commission. In 1915, 616 retorts were put into commission. From April, 1916, until the early part of this year, eight furnaces, containing 1,536 retorts, were erected and ready to operate. We understand they are also now contemplating the erection of large roasting and sulphuric acid plant. This is a feat which can only be accomplished with a sound organisation, and denotes the vigour which our friends across the border have thrown into the fray at a time when material was so scarce.

The English Crown Spelter Company, Limited, Swansea, is a very old-established concern, possessing its own mines in Italy. This firm has increased its distillation department with an addition of about 700 to 750 retorts. They are also erecting a large roasting and sulphuric acid plant and retort-making plant. They have been ably guided by the chairman, Mr. Francis, the secretary, Mr. Redout, and the manager, Mr. E. Ruck, who are well known in the spelter industry. The Swansea Vale Spelter Company, Limited, Swansea, and the Sulphides Corporation, Seaton Carew, have effected enormous extensions to their distillation, roasting and sulphuric acid plants, and retort-making departments, and further extensions are under consideration. We will briefly note the extensions effected at the other works, as space will not permit us to go into details.

The New Delaville Spelter Company, Limited, Bloxwich, makers of high-grade spelter; extensions to retort-making department.

The Dillwyn Spelter Works, Swansea; large roasting extensions.

The Vivians Spelter Works, Swansea; large roasting extensions.

The Villiers Spelter Works, Swansea; extensions to distillation department and retort-making department.

The Frickers Metal Company, Limited, Luton, possess a special process for the manufacture of pure spelter.

As already mentioned, unfortunately with all these important extensions our production is still inadequate. This is a good opportunity for the galvanisers, or other large users of spelter, and the sulphuric acid manufacturers of the country to combine and produce these valuable commodities. Technical advice is obtainable, and surely capital as well.

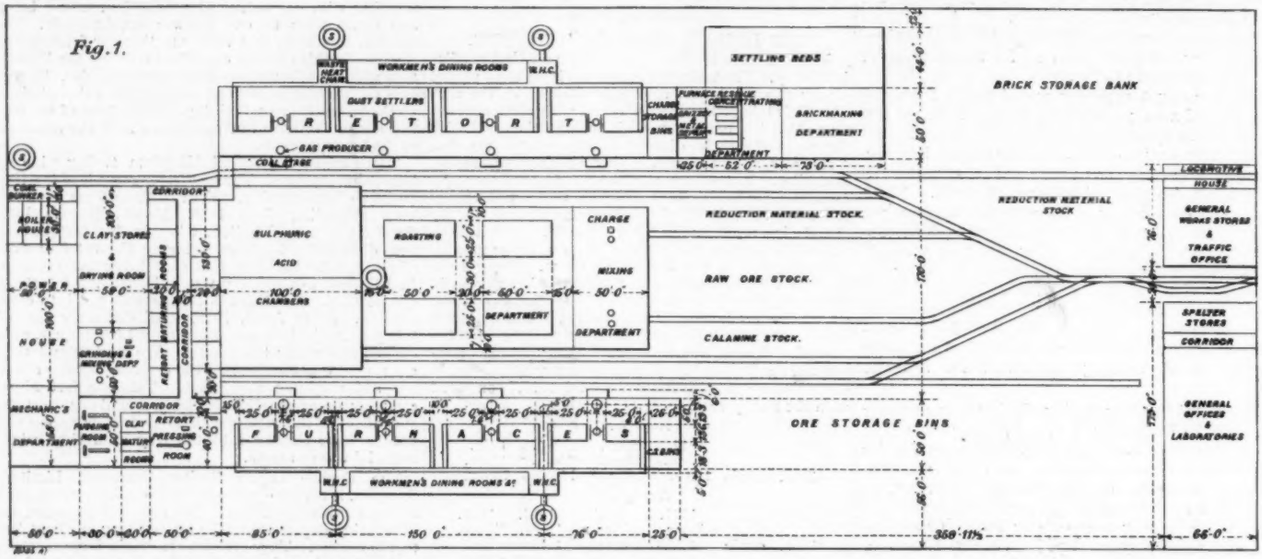
Before it is possible to install a plant for the production of spelter it is necessary to obtain the fireclay retorts in which the mineral is distilled. These retorts form the essential feature of a distillation furnace, and although in years past several engineering firms in the country have been in a position to supply the plant for the manufacture of these retorts, owing to reasons which need not be entered into here practically the whole of the retort-making presses in use up to the present time have been manufactured on the Continent. In order, however, to deal with the large increase of concentrates from Australia the spelter manufacturers have been compelled to increase their retort-making plant, including roasting and distillation furnaces, &c. To this end the firm of William Johnson and Sons (Leeds), Limited, have commenced a new department specially for the construction and equipment of spelter works plant, and we propose to give some account of the appliances. They have four plants on order at the present time and several others are being negotiated. The plants include the pugging and preparing machinery for preparing the raw fireclay, &c., and a special type of hydraulic press in which the retorts are moulded and finished, together with the necessary pumps and accumulators. Messrs. Johnson and Sons,

who are well known in connection with the manufacture of general clay-working machinery, have for several years past supplied the grinding and mixing plant in which the raw clays are ground and thoroughly mixed before being fed to the pot-making plant. This section of the works has usually been equipped by British engineering firms.

We will first briefly indicate what zinc plants, such as we illustrate in Fig. 1, annexed, have to do.

In the plan, Fig. 1, the front is taken up by the general offices and laboratories, as well as by the

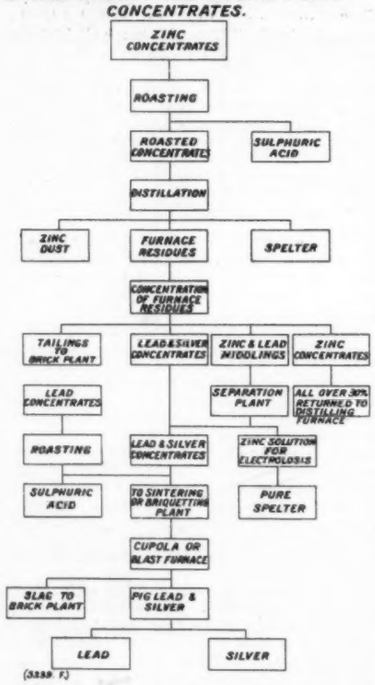
Fig. 1.



general traffic offices and spelter stores, whilst the power and boiler houses, with the coal bunkers, are at the back. To have the railway tracks enter and leave the works through the middle of the front and to have them distributed systematically in two branches, both serving the roasting and acid-making departments in the centre, and each further serving the mineral stores and one of the two lines of zinc-distillation furnaces, will have its advantages, provided a thoroughly suitable site can be secured. The spacious ore storage bins are on the left, the brick bins on the right, and further materials are stored in the central space. The retort (zinc-distillation) furnaces run along both sides, with the producer-gas furnaces feeding them in front, and the dust settlers and bag sheds, and the waste heat chambers and chimneys behind. The inner space is occupied by the department in which the charges for the roasting and distillation from furnaces are mixed, and by the lead chambers in which the sulphur dioxide from the roasting furnaces is converted into sulphuric acid. Beyond are the clay and retort departments, comprising clay stores, drying and maturing rooms, rooms for grinding and mixing the retort materials—fresh and also old, fragments of used retorts so far as utilisable for the making of adapters, &c.—and the pugging, drying and baking rooms for the retorts. Between the distillation furnaces and the front of the works there are to be seen, in the upper corner of the diagram, the charging bins for the retorts and the department for concentrating furnace refuse; there the cadmium, lead and silver, and other metals which are produced together with the spelter, are separated or prepared for further treatment. We now pass to particulars, beginning with the ores, the general process of treating Australian zinc and lead concentrates being shown graphically on the annexed flow sheet.

For some time past zinc-blende, ZnS, has been the main source of zinc production. White in the pure state, blende is generally a brown or black mineral in which the zinc is associated with cadmium, a regular constituent of all zinc ores, and accompanied by lead, iron, manganese and other sulphides, and further by the quartz, calcite, &c., of the gangue. Arsenic is not so common in blende as antimony; small amounts of silver are frequent. Calamine $ZnCO_3$, formerly the most valued zinc ore, has become rare. The silicate Zn_2SiO_4, H_2O is also known under the unfortunate name of electric calamine. Of less general occurrence, though locally very important, are willemite (an anhydrous silicate), hydrozincite (zinc bloom, a carbonate and hydrate), red ore (an oxide, red with iron oxide), and franklinite (a complex oxide); these last two form the staple ores of the big New Jersey zinc works. In many cases various ores are mixed and receive much the same treatment. The blende is roasted to remove the sulphur as SO_2,

FLOW SHEET SHEWING PROPOSED METHODS OF TREATING AUSTRALIAN ZINC & LEAD CONCENTRATES.



remove minerals which might appear harmless, such as calcite, because they would, in the roasting, combine with the sulphur to a slag and prevent its volatilisation. Fluorspar is very objectionable because the volatile SiF_4 formed during the roasting yields highly corrosive acid, attacking brickwork also; flotation does not successfully eliminate carbonates and fluorspar. When reading a paper on the "Utilisation of the Sulphur Contents of Zinc Ore" quite recently before the Society of Chemical Industry, Mr. H. M. Ridge mentioned a case in which chlorine had caused trouble in the lead chambers; the chlorine came from the sea water spray to which the ore had been exposed at Port Pirie in South Australia.

The roasting requires muffled furnaces, because the fire gases should not mix with the SO_2. The oxidation of ZnS generates heat, and the roasting process should thus proceed spontaneously when initated; but any sulphates formed have to be redecomposed by heat, and the oxidising sulphides may melt and solidify to hard lumps, to be broken up again. Calamine used to be burnt in heaps like charcoal. The roasting of blende is not so simple, and the substitution of large furnaces and of machinery for the hard and unhealthy manual labour has not always been satisfactory; what is saved in labour is often spent in repairing the huge, somewhat inaccessible furnaces. In general the ore is spread on a hearth, and rabbled and thrown on the floor beneath, where the process is repeated. Inclined hearths of the conveyor type have been tried. In the Hegeler furnace ploughs are drawn by long rods, which slowly move forward and backward by chains over six and more superimposed hearths; for a hearth length of 120 ft. nearly three times that floor space is wanted, since the rods project at the ends of their travel, to be cooled in the open. In the Spirlet furnace the hearths are rotating discs set with radial lines of bricks on their lower surface to stir the ore on the hearth underneath, which is rotating in the opposite direction; such arrangements do not hold out long when the ore cakes and freezes. Mr. Ridge makes the uppermost of his five hearths the drying floor, and passes four vertical stirrer shafts right through them; each shaft is water-cooled and driven by its own 10 h.p. motor, and the radial rabbles, attached to the shafts to sweep over the hearths, are built up of pieces weighing only 5 lb. each, which are easily replaced. In these gas-fired furnaces, in which the gas is burnt only under the bottom roasting furnace, he claims to roast Broken Hill ore down to 0.75 per cent. of sulphur with a feed of 12 tons of ore per 24 hours and a coal consumption of 10 per cent. Roasting furnaces for zinc ores, of various types and designs, both manual and mechanical, are now under trial or in operation in the North and West of England, in Lancashire, the Midlands and Wales. They differ materially from the pyrites burners used by the sulphuric acid makers and experience for their operation has to be acquired. Commenting upon these facts in his annual report for 1916, the chief alkali works inspector remarks that, as regards this country at all events, the mechanically-worked furnaces may still be regarded as in the introductory stage.

The ground roasted zinc oxide, which still contains some sulphide and sulphate, silicates and the other metals, is mixed with fine coal and reduced in retorts at temperatures between 1,100 deg. C. and 1,300 deg. C. Both carbon and carbon monoxide, CO, are believed to react with the zinc oxide; but molten zinc redecomposes any CO_2 formed, and the reactions are by no means clear, in spite of many researches. The first real investigation of the equilibrium conditions was, in fact, only communicated to the Bunsen Gesellschaft in December last by Bodenstein and Schubart. It ought to be possible to effect the reduction at lower temperatures and higher pressures, or, with the aid of catalysts, at ordinary pressure; but Bodenstein had little belief in the technical outlook of such processes as have been tried. Practically the reduction has not so far been successful in shaft furnaces, because the zinc vapour, when strongly diluted with CO and CO_2,

DAMAGED CYLINDERS OF INTERNED GERMAN STEAMER IN BRAZIL.

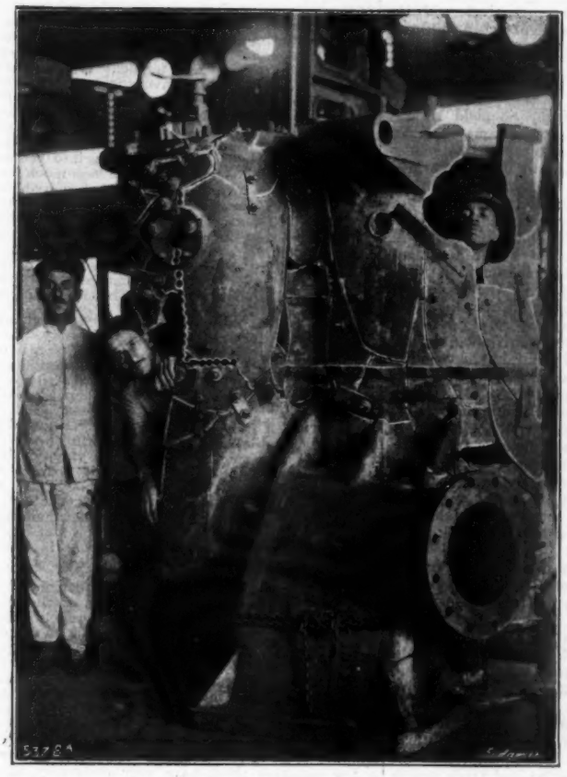


FIG. 1.

FIG. 2.

will not liquefy, but will condense as zinc dust which—if not utilised as such as a reducing agent in dye works and in cyanide baths, or oxidised to zinc white, or used as a rust-preventing paint for iron and for sherardising—has to be fused or redistilled to make zinc metal proper. Experimenting with shaft and reverberatory furnaces continues. Meanwhile, however, the reduction proceeds in tubes, muffles or retorts, and it is far from being perfect. At the best zinc losses of 10 per cent. can hardly be avoided—with Broken Hill ore the losses generally seem to amount to 15 and even 20 per cent., in fact—and the items for coal, labour and muffles are heavy, so that the extraction of poor zinc ores hardly pays. Zinc dust, containing not more than 10 per cent. of zinc oxide, is a valuable material; the dust from the flues is less pure.

(To be continued.)

REPAIRS TO INTERNED GERMAN VESSELS IN BRAZIL.

On this page we reproduce two photographs of the damaged high-pressure cylinders of one of the German merchant ships interned in Brazil, as a result of the declaration of war between Brazil and Germany, as they illustrate the thoroughness of German destruction. The number of German vessels interned was approximately 45, totalling 235,000 gross tons. These had been more or less all seriously damaged, particularly the propelling machinery, and in some cases new cylinders throughout had to be made; in others only portions of the cylinders had been destroyed. The thoroughness of the work done by the German engineers is suggested by the fact that in one case of two damaged cylinders at least 8,000 holes must have been drilled transversely and vertically through the cylinders, in order to effect complete destruction. Several of the vessels were taken over by the Brazilian Ministry of Marine and others by the Lloyd Braziliero Company.

In the early part of 1917 the Brazilian Government invited Messrs. Vickers, Limited, who had placed their experience at their disposal, to send an engineering technical officer to Brazil to survey the damage to the machinery and carry out the necessary steps for its repair. It was found that not only could the work be carried out in Brazil itself, but in the naval arsenal of that country. It was therefore decided by the Ministry of Marine to proceed immediately with the re-casting of the damaged cylinders and liners, and great credit is due to the engineering officers of the Brazilian Navy and to the *personnel* of the arsenal, not only for executing the work, but for the expedition with which it was carried out.

The photographs we reproduce are of the high-pressure cylinders of a quadruple set of engines, the respective diameters being 26$\frac{7}{16}$ in., 38$\frac{3}{4}$ in., 56$\frac{3}{4}$ in. and 81$\frac{1}{4}$ in. by 54 in. stroke. The cylinders illustrated had been broken into hundreds of small pieces, and in order to make new cylinders to suit the set it was necessary to collect as many pieces as possible and to erect them as illustrated, so that the dimensions of the cylinders could be measured accurately. When erected, photographs were taken, and we are indebted to the Brazilian Minister in London for permission to reproduce these photographs. Portions of cylinders were also re-cast and welded in position in the engineering workshops in Brazil.

It is an interesting fact that most of the broken parts of the machinery were, in the case of the greater number of vessels, carefully stored between decks, evidently in order to be used as scrap metal in Germany, in the event of the return of the ships to the "Fatherland."

THE INDUSTRIAL RECONSTRUCTION COUNCIL.—The Lord Mayor will preside at the inaugural meeting of the Industrial Reconstruction Council which is to be held on Friday, February 15, at 3 p.m., at the Guildhall, London. Dr. Addison, Mr. G. H. Roberts, Lord Burnham, Mr. J. H. Whitley, and other speakers representative of all industrial interests, will deal with the practical problems of Industrial Reconstruction. This is the first of a series of important meetings which the Reconstruction Council is arranging with the object of focussing public opinion upon the tremendous industrial problems that will arise at the end of the war. Applications for tickets should be made to the Secretary, the Industrial Reconstruction Council, 8, Bouverie-street, E.C. 4.

DIESEL ENGINE USERS' ASSOCIATION.—The first meeting of the Diesel Engine Users' Association since the election of its new president, Mr. Napier Prentice, was held on January 31. The hon. secretary reported recent communications with the Controller of Munitions, Mineral Oil Production, in connection with the subject of fuel oil supplies and the use of tar oil as fuel in Diesel engines. He further reported the appointment by the Controller of a committee to assist him in these matters, especially in connection with applications for licences to use tar oil, and of methods to adapt Diesel engines for the use of tar oil. This committee is to be styled the Heavy Oil Engine Fuel Committee. It is composed of the nine members of the General Committee of the Diesel Engine Users' Association, to which have been added two further members nominated by the Institution of Electrical Engineers. The hon. secretary of the new committee is Mr. Percy Still, M.I.E.E., and the offices are at 19, Cadogan Gardens, S.W. 3. Mr. John Milton read some notes giving the results of his experience in the use of tar oil as fuel in Willan's Diesel engines without pilot ignition apparatus. These notes, and the discussion which followed, produced a considerable amount of very useful and practical information on a subject which is of particular interest and importance to all users of Diesel engines at the present time.

THE LATE MR. CHARLES WEBSTER, M.I.N.A.—We regret to record the death of Mr. Charles Webster, who, since 1891, had been chief draughtsman in the works of Messrs. J. I. Thorneycroft and Co. He entered the employ of that firm in 1882, and so for thirty-five years had been associated with them. He served his apprenticeship as an engineer at the London and North-Western railway works, Crewe. He attended three sessions at Owen's College, Manchester, from 1878 to 1882, taking up the natural philosophy and engineering courses. During this period he obtained in succession, the Ramsbottom, Rumney and Bremner scholarships, together with other distinctions, and in 1882 he headed the list of Whitworth Scholars for that year. He studied engineering under the late Professor Osborne Reynolds, by whom he was recommended, at the close of his college training, to Messrs. J. I. Thornycroft and Co., and he entered the employ of this firm at their Chiswick works, as a ship draughtsman in June, 1882. In 1891 he was made chief draughtsman, in which capacity he was occupied till 1910. At this time the Russian Government commenced building some torpedo-boat destroyers for their Black Sea fleet from designs prepared by Messrs. J. I. Thornycroft, Southampton, and Mr. Webster was sent out to supervise the construction of these vessels, which were completed with very satisfactory results. He subsequently resumed charge of the calculating department of the ship drawing office at Messrs. Thornycroft's works at Southampton, and died on February 5, after some months' illness, at the age of 56.

INDUSTRIAL NOTES.

Recent decisions given by the Committee on Production and the Special Arbitration Tribunal on cases which have been referred to them by the Ministry of Labour, including cases arising out of the Orders under which a bonus to munition workers has been given, cover the following: Ironfounders, North-East Coast engineering trade; chemical, explosives and allied trades; sailmakers, Clyde Sailmaking Employers' Association; boilermakers, the Manchester Dry Dock Company, Limited; chargers at the Consett Iron Company, Limited, Durham; caulkers at Messrs. D. and W. Henderson, Ltd.; the building trade, Sheffield; the National Projectile Factories, Glasgow; apprentices, South Wales and Monmouthshire Iron and Steel Association; and charge-wheelers and ladlemen, at Messrs. Dorman, Long and Co., Limited.

In a recent case adjudged by Sheriff Fyfe, he held a Clyde firm liable in payment of a week's wages to each of 150 ironmoulders who, when they returned after the New Year holidays could not get a start for a week, owing to a dispute which had arisen during the holidays with the Millmen's Union; till this was settled, gas was not available to enable the moulders to start work. The sheriff stated that no provision had been made in the new, 1917, Act for temporary suspension of work for causes beyond the control of either employers or employees. It was not the intention of the Act that every suspension of work should automatically entitle a workman to receive a sum equivalent to a week's wages; on the other hand, a leading purpose of the Act would be defeated if an employer could keep men hanging on from day to day, earning no wages, and waiting to start work. As regarded intermittent suspension of work, he applied what he called a reasonable commonsense interpretation to the new Act, and reverted to the principle of the 1916 Act, which Section 3 of the new Act had supplanted, to the effect that the risk of suspension of work should be with the workman for two days, and with the employer after that. As the suspension in this particular case had lasted more than two days, he held that the service contracts were on the third day determined within the meaning of Section 3, and that when the men resumed work in the following week they had entered upon new contracts of service, but that nevertheless the compensation of a week's wages became payable when first contracts were ended without a week's notice. In regard to the amount of compensation, he held that the tribunal had no discretion, as they had under the 1916 Act, to assess compensation relative to the actual loss sustained, but were bound under the new Act to award a sum equivalent to a full week's wages, whether the men's actual loss was greater or less than a week's wages.

Speaking in Leeds, last Monday, on trade after the war, Dr. Addison, M.P., Minister of Reconstruction, said that for the improvement of our industry it was most important we should have as soon as possible representative organisations both of employers and of employed. The trades should group together to suit themselves; every employer in an industry should be in the employers' association, and every workman in the trade union. Once the organisations were formed, he was content to leave them to the future. So far as they succeeded they would be permanent and an improvement, and so far as they failed they did not deserve to live. There should be both a complete employers' association and a complete employees' association, but it was essential that there should also be a joint body representative of the whole of an industry, some organisation that would provide a free method of consultation and discussion.

Dr. Addison added that a multitude of thorny labour questions would arise immediately after the process of demobilisation began, and they could be dealt with efficiently by a joint body if the members addressed their minds to the questions beforehand; it would be impossible to deal with them in the hurry and pressure of demobilisation. Another matter to be dealt with was the fixing of arrangements between employers and employed, making for the removal of restrictions on output, which he believed must be removed if we were to escape national bankruptcy. The clearing away of all limitations on output and the establishing of a free course for the introduction of improved industrial methods could only be done by means of an agreement made by people who understood the business. Security of employment was also a question which could be dealt with by the joint organisations.

A further question in which their assistance was wanted was the one relating to raw materials, since the British trades had to prepare, for a time at least, for a real or artificial shortage of raw material. A committee was wanted, arranged by the trades themselves, to advise the Ministry of Reconstruction upon quantities of supplies and the order of their importance. New processes of manufacture had also to be investigated, and he believed that in our skilled craftsmen we had a wealth of suggestion and invention which we had never explored or made use of as we ought to have done.

The Ministry had decided to communicate with the Colonies and Dependencies with the object of collecting complete information in the matter of after-war requirements; it was safe to say that these would be prodigious.

At the quarterly meeting of the Sheffield District Committee of the Council of the Amalgamated Union of Labour held on Saturday last, a report was handed in by the executive in regard to colliery surfacemen's wages and hours. The report stated that the colliery surface workers of South and West Yorkshire had endeavoured since the commencement of 1917 to secure a minimum wage and an eight-hour day for all surface men, and from the Doncaster area a demand was made for a 1*s.* per hour advance on basis rates. No success had been reached until the middle of January, 1918, when negotiations were reopened, and eventually the whole question was referred to the Committee on Production. An award issued by the latter, dated January 29, fixed a minimum wage for almost every class of surface worker. The 1915 agreement was brought up to date to include in it the rates, &c., paid to manipulators. In reference to the action in the Doncaster area the Committee had given minimum wages to practically all classes of workers.

After discussion, a resolution was agreed upon, accepting the award of the Committee, but regretting that it had declined to give an eight-hour day. The meeting declared its policy to include the eight-hour day, and that this should be a leading plank in its after-war programme.

It was further stated at the meeting that on the quarter ending December 31 last, 34 important wages questions had been dealt with, which affected 14,469 members, and had resulted in an annual wages gain of 226,527*l.*, which, with the advances previously gained during the year, totalled 690,420*l.* During the same period compensation had been received in disputed cases amounting to 4,224*l.*

We are informed that 20,000 skilled shipyard men are to be released from the army, and that a small Joint Executive Committee has been appointed by the Shipbuilding Employers' Federation and trade unions to assist the Government in distributing them.

Speaking in Parliament last Wednesday, the Chancellor of the Exchequer, dealing with the question of shipbuilding, said that in judging the situation, account had to be taken of the demands made on manpower and on steel. The extent to which steel had been used for items for which it had not been used before had to be remembered. In 1916, the total quantity of ships built was 539,000 tons. In 1917, the tonnage built in this country was 1,163,474 tons, and we secured abroad 170,000 tons in addition. We had arranged for a large quantity of tonnage which was to be built in and supplied from America; but when the American Government came into the war, they preferred, as we should have done, to use that tonnage themselves. The tonnage, however, existed, and it was in the service of the Allies.

Before the war, he added, every 100 tons net shipping which came into this country brought 106 tons of goods. Now, by the arrangements made to utilise every inch of space, and by taking the best method of loading, every 100 net tons of shipping coming into this country brought, on the average, 150 tons of goods.

Large New Aluminium Works.—It is interesting to note the amount of attention which has recently been bestowed upon the production and the use of aluminium, which metal has gained many new friends and found many new applications during the war. In Norway, a new aluminium company has been formed under the style of Nordisk-Aluminium-Industri, with a capital of 1,000,000 kroner, the works, which in every respect are to be fully up-to-date, are to be located at Hinna, and several hundred workmen will be employed.

Scarcity of Copper in Sweden.—Owing to the great scarcity of copper which at present prevails, the Government has requisitioned all stocks of copper, raw or worked-up, electrolytic or otherwise, and all copper scrap and other scrap containing copper. The Order took effect on January 18, and comprises all stocks of more than 10 kg. (22 lb.). Full particulars of existing stocks had to be handed in to the authorities within a week of the above date. Industrial concerns have the right to use 10 per cent. of the stocks in question within thirty days of the decree coming into operation. For more extensive uses and for any use after February 16, special permits from the Industrial Commission are required. For the future all metal scrap has to be sold to the Metal Bureau of the Industrial Commission or to such persons who have obtained permission to deal in such goods.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Scotch Steel Trade.—Despite the impression reflecting discredit on the Clyde workmen which has been set in motion by a certain unpatriotic and irresponsible section of the community, the steelmakers throughout the entire West of Scotland were never more fully occupied, never made greater efforts to increase the output alike of the material required by Governments and by the general home consumer. Pressure for delivery is constant and compelling, and every endeavour is being made to work off the most important orders with the greatest possible despatch and so prevent any further accumulation of arrears. Every ton of steel produced is immediately taken up by Government either directly or indirectly, with the result that very little goes into general use, and this unavoidable shortage causes much anxiety. Every sort of manufactured steel required for the prosecution of the war is in phenomenal request, that necessary for constructional purposes in the shipbuilding yards being exceptionally so. Ship plates and sections, therefore, and steel for shell bars take first place. Never was there more activity in the Clyde yards and engineering shops than at the moment, and to keep this going the steelmakers work at the same high pressure.

Malleable Iron Trade.—As in every branch of local industry malleable ironmakers find difficulty in meeting the many demands made upon them. The rate of production is much in excess of anything hitherto known in the district, yet there is a certain dissatisfaction amongst those clamouring for material that it cannot be delivered quickly enough to suit their purposes. The lighter sections of bar iron are in particularly heavy demand, and all the available plant is fully occupied. With the basic steel mills running constantly a very considerable output is being obtained, and this is proving a very valuable addition to the output of the large steel works, especially as the demand for this product is constantly on the increase. So long as the heavy demands on home account continue there is little prospect of any great increase of export business. For what is being put through at the present time fairly stiff rates rule.

Scotch Pig-Iron Trade.—The active demand for pig-iron of all grades continues to be one of the principal features of the trade, the local steel works in particular being constantly in the market for large supplies of hematite. Orders are so well booked up that priority of claim is more important than ever, and the most urgent demands must be met first to the almost total exclusion of the ordinary mercantile consumer and the overseas' trader as well. The necessities of Government have played havoc with the export trade in the meantime and while rates remain on a very satisfactory basis, from the point of view of the producer and seller, in quite a few instances these have very materially advanced during the past few days.

Clyde Workers and Man-Power.—During the past few days mass meetings have been held of the workers, both men and women alike, employed in, practically, every establishment on the Clyde—shipbuilding yard, engineering shop and munition factory—when resolutions have been unanimously passed by which the workers pledged themselves to support the Government in the most wholehearted manner possible. In every instance the Clyde workers have made vigorous protest against the attitude taken up by those present at the meeting addressed by Sir Auckland Geddes a fortnight ago. The general feeling is that the war must be fought to a successful termination and that no sympathy can be extended to any maudlin pacifist movement.

Swedish Industrial Activity.—Developments on a large scale continue within the Swedish industry. One of the most notable moves of recent date is the formation of a large central Swedish mining company under the style of Mellansvenska Malmfälten (Central Swedish Mining Company), with a capital of 18,000 000 kroner. The new company which, next to the Grängesberg-Orelösund Traffic Company, will be the largest mining company in Sweden, controls some important deposits, to a great extent bought back from foreign owners. The Grängesberg Company is itself interested in the new undertaking, and an arrangement has been arrived at between the two companies, so that their interests do not clash on foreign markets. The annual production of the Central Swedish Mining Company is in the meantime calculated at 500,000 tons. The new paper textile industry seems to be gaining ground, and much faith is expressed in its chances. Another company, the Ornsbergs Paper Spinning Mills, has been formed with a minimum capital of 1,000,000 kroner. Plenty of raw material has been secured, and work will commence in the course of a couple of months. Manufacture, in the first instance, will be confined to coarser articles, tying yarn, bags, mats, &c., but it is confidently anticipated that the manufacture can, 'ere long, be placed on a broader basis. The new State Oil Company, with a maximum capital of 15,000,000 kroner, is attracting increased attention, inasmuch as its scope appears to be wider than was at first anticipated. The company's work will not be confined to oil extraction from shale; it will deal also with another product, sulphur, and the two, oil and sulphur, will in the first instance form the mainstay of the company. As a start, a daily production of 2 tons to 3 tons of raw oil is reckoned upon, but in the course of a couple of years, the production, it is expected, will rise to 10 times that quantity. The capacity of the shale deposits in Sweden is estimated at a very high figure. The putting down of a large power station is also on the company's programme.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Supply of Materials.—The general situation has been immensely relieved by the better tone which characterises the relations of the Government with the engineers. A recrudescence of industrial unrest at the present time would be a calamity, and the general feeling in the city is that the older heads in the trade will exercise such a restraining influence on the young "bloods," as will ward off any serious trouble. The stoppage in South Wales has caused a shortage of basic steel, at a time when every ton that can be produced is of paramount importance. Government requirements are largely for this quality, and although there has been a fair supply locally, consumers are practically working from hand to mouth. The shortage in certain alloys has hampered production. Complaints, too, are received of the waste of time and trouble caused by the multitude of forms which are required to be filled up at every turn and corner. The Ministry of Munitions has recently been exceptionally active in enforcing adherence to the steel control regulations, with the result that many firms who have either been somewhat lax or too busy to carry out the innumerable requirements of the Government have found themselves in an awkward position. There is still a shortage of forge and foundry pig, and the supply of finished iron is not to requirements. The amount of steel and iron scrap available is below the demand, notwithstanding the huge production of steel melting scrap, turnings and borings.

South Yorkshire Coal Trade.—Business on the Coal Exchange this week was of a normal character. The demand for all classes of coal for inland requirements is at a maximum, and the output is absorbed on contract account. Small fuel, especially washed nuts, is very scarce. The pits are working well, a settlement having been arrived at in the various disputes which were hampering production in the South Yorkshire coalfield. Exports are on an increasing scale. The bulk are on Government account, but a substantial tonnage has been moving to France and Italy. Large coal and cobbles are somewhat more plentiful. Slacks are scarce and in very heavy demand. Coke is firm at maximum prices. Quotations at the pit are as follow:—Best branch handpicked, 23*s.* to 24*s.*; Barnsley best Silkstone, 23*s.* to 23*s.* 6*d.*; Derbyshire best brights, 21*s.* to 22*s.*; Derbyshire house coal, 18*s.* 6*d.* to 19*s.* 6*d.*; best large nuts, 18*s.* 6*d.* to 19*s.* 6*d.*; small nuts, 17*s.* 6*d.* to 18*s.* 6*d.*; Yorkshire hards, 18*s.* 6*d.* to 19*s.* 6*d.*; Derbyshire hards, 17*s.* 9*d.* to 18*s.* 9*d.*; best slacks, 14*s.* to 14*s.* 6*d.*; seconds, 13*s.* to 13*s.* 6*d.*; smalls, 9*s.* to 10*s.*, per ton at the pit.

ELECTRIC STEEL IN THE UNITED STATES.—In the United States during 1917 there was an increase of nearly 100 electric furnaces, or from 136 on January 1, 1917, to 233 on January 1, 1918, according to *The Iron Age*, New York. The increase is, in fact, over 100, some furnaces having been contracted for but not made public. The expansion since January 1, 1915, has been nearly sixfold. The development in the United States in the last two years, particularly in 1917, has been marked by two important features. The installations in the majority of cases has been of larger furnaces. Of the 62 Héroult furnaces credited to 1917, only 12 were of 3 tons or less, the remainder having been mostly 6-ton units, with the exception of five installations of 10-ton to 25-ton furnaces. The other feature has been the growth in electric steel plants of several units having large total capacity. There are now no less than seven steel companies in the United States having from four to six electric furnaces, all producing special steels on a large scale. There are also two such large companies in Canada.

MERCURY STILL OF SILICA GLASS.—Electrically heated apparatus, generally made of glass, for distilling mercury are no longer rare in large laboratories. When such stills are directly joined to the lamp wires, an accidental rise in the volts of the mains may lead to the overheating of the glass and its collapsing under the pressure of the atmosphere. As this had happened several times in the Geophysical Laboratory of the Carnegie Institution, J. C. Hostetter and R. B. Sosman (Journal of the Washington Academy of Science, January, 1918) built their still up of fused silica. The distillation vessel is a closed cylindrical cup, 30 mm. diameter, 110 mm. high, forming the upper end of a barometer tube; the mercury vapours pass through the bent neck of the cup into the condenser, a wide tube (13 mm. in diameter) which is joined above to a suction pump, and below to another tube, of more than barometric height, in which the condensed mercury collects. The two barometer tubes, which should have an internal diameter of 5 mm., are of transparent silica, so that the liquid levels can be watched; the other silica need not be transparent. The cup is surrounded by an alundum cylinder, on the outside of which the nichrome resistance is wound, and the furnace which is packed with asbestos. The nichrome is joined directly to the 110 volt lamp circuit. One case of a collapsing glass still was interesting; the vessel did not flatten out when overheated, but yielded symmetrically around its vertical axis, producing a figure with three cusps separated by angles of 120 deg. The object of the distillation is to purify the mercury. A preliminary purification is most advisable, however; this can be effected in various ways, for example, by letting a fine stream of the mercury fall through a high column of diluted nitric acid. The simple Leffman process is also said to be very effective; the contaminated mercury is shaken with a solution of cane sugar and then filtered through a pin hole.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Practically all the contracts for Cleveland foundry pig iron under the February allocations have been made, and business is quiet, traders now devoting attention to arranging deliveries. The difficulty in regard to distribution is unfortunately unrelieved and the scarcity of trucks and labour is such that in all probability deliveries will again be heavily in arrears at the end of the month, involving the cancellation of allocations which have not been fulfilled. Rather heavy inquiries for forge iron on forward accounts are reported, but as makers are not disposed to commit themselves ahead to any great extent, they do not result in much business. Export trade is very quiet. For home consumption, No. 3 Cleveland pig, No. 4 foundry, and No. 4 forge are all quoted 95*s.*, and No. 1 is 99*s.*; and for shipment to France and Italy, No. 3 and the lower qualities all stand at 114*s.*, and No. 1 is 119*s.*

Hematite Iron.—Recent restriction in the production of East Coast hematite iron has intensified the necessity of careful distribution so as to ensure the satisfying of home needs, and after these have been dealt with, the distribution of the surplus iron available for export to the Allies. Nos. 1, 2 and 3 are 122*s.* 6*d.* for home use, and 147*s.* 6*d.* for shipment to France and Italy.

Foreign Ore.—A very gratifying substantial improvement in deliveries of foreign ore is reported. The recently sanctioned advance in price has induced merchants to operate. Apparently, however, as yet, there is no official ruling as to whether the advance applies to contracts made prior to the rise.

Coke.—A quite plentiful supply meets the large demand for coke and business is brisk. For home use, foundry description is 38*s.*, average blast-furnace quality 33*s.* at the ovens, and low phosphorus sorts 35*s.* 6*d.* at the ovens. For export, foundry coke is 42*s.* 6*d.* f.o.b. for the Allies, and 45*s.* f.o.b. for neutrals.

Manufactured Iron and Steel.—There is little new ascertainable concerning finished iron and steel. Large demand for shipbuilding material is receiving adequate attention, output of plates and angles being very heavy; and huge supplies of steel for munition purposes are going steadily forward. Beyond the exports to meet the pressing needs of France and Italy scarcely any finished iron and steel is being shipped abroad. To home customers common iron bars are 13*l.* 15*s.*; best bars, 14*l.* 2*s.* 6*d.*; best best bars, 14*l.* 10*s.*; iron ship plates, 15*l.* 10*s.*; iron ship angles, 13*l.* 15*s.*; packing iron and steel (parallel), 13*l.* 10*s.*; packing iron and steel (tapered), 15*l.* 15*s.*; steel bars (no test), 15*l.*; steel ship plates, 11*l.* 10*s.*; steel ship angles, 11*l.* 2*s.* 6*d.*; steel boiler plates, 12*l.* 10*s.*; steel joists, 11*l.* 2*s.* 6*d.*; steel billets, 11*l.*; and heavy sections of steel rails, 10*l.* 17*s.* 6*d.* There are no fixed prices for export, but they may be given as approximately 40*s.* above the home quotations.

Manufactured Ironworkers' Wages.—According to the return of the accountants to the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England, the average net selling price of iron plates, bars and angles for the two months ended December 31 last was 13*l.* 14*s.* 5.70*d.*, as compared with 13*l.* 15*s.* 4.29*d.* for the previous two months, and under sliding scale arrangements manufactured ironworkers' wages for February and March remain the same as prevailed during the preceding two months.

BITUMINOUS COAL OUTPUT IN THE UNITED STATES.—The bituminous coal output for 1917, says *The Iron Age*, New York, is placed by the United States Geological Survey at 544,000,000 tons, an increase of 42,000,000 tons over 1916. This is about 6,000,000 tons below the estimate of Fuel Administrator Garfield, the difference being due to a falling-off in production during December, when, because of car shortage, output was the smallest since last April. The last week in December showed marked improvement, but the mines were still 12 per cent. below their total capacity. The fuel administration announces that America's coal exports this year will be limited to shipments for war purposes, and to those necessary in exchange for commodities the United States import most. A heavy reduction in exports as compared with 1917 will be positively insisted upon.

JAPANESE SHIPBUILDING SUBSIDIES.—The Shipbuilding Encouragement Law, which came into force in 1896 and was amended in 1910, gave a powerful impetus to the shipbuilding industry of Japan, and the European war greatly accelerated the development of that industry, says *The Marine Journal*, New York. Under the Japanese 1910 amendment, vessels are divided into two classes and four groups. Class A comprises vessels containing not less than 50 berths of first or second class, or one cabin or second-class berth for every 100 gross tons or fraction thereof; while Class B comprises all other types of vessels. The four groups cover ocean-going steamers, near sea vessels, coasting vessels and smooth-water vessels. The rate of subsidy per ton of gross tonnage is as follows:—

	Class A. Yen.	Class B. Yen.
First group	22	19
Second group	21	18
Third group	19	16
Fourth group	14	11

The value of a yen is slightly above 2*s.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Local Markets.—Chief interest at the present moment is centred in the proposed new allocation rules regarding the supply of coals to France and Italy. The main object of the proposals of the special committee appointed to deal with the matter is to establish a uniform method of procedure at all the coal-exporting districts, and at a meeting of the Cardiff exporters held yesterday it was decided to approve of the proposals. Another subject of general discussion is the Coal Controller's proposal to deprive exporters of their usual one-third of 5 per cent. Resistance to this proposal is taking organised form. There is otherwise no change to report. A number of collieries have been idle during the past week, but this week the great majority have been working.

Newport.—Inland requirements have kept the pits working fairly regularly. The owners in the Eastern and Western Valleys are favourably inclined towards the adoption of the proposed allocation scheme, and under these circumstances it is probable that the work of distributing orders will be undertaken at an early date.

Anthracite Hauliers' Demands.—The hauliers of the anthracite district have now definitely formulated their demand for improved conditions, and the claim will be formally submitted to the next meeting of the South Wales Miners' Federation. Although termed, for brevity's sake, "the hauliers' demands," the claims put forward are on behalf of riders, hauliers, shacklers and trammers. The main points put forward are: (*a*) To claim not less than 7*s.* 6*d.* per day standard and current percentages; (*b*) where two hauliers are working the same parting, half a shift per week to be paid for dividing the turn, and where there are more than two hauliers driving to the same parting, one turn per week to be paid, &c.; (*c*) where hauliers, riders, trammers and shacklers have to work in water, a turn extra per week shall be paid; (*d*) a lump sum of 1*l.* to be paid for breaking a horse in; and (*e*) turn a week to be paid for a horse that is a kicker. The workmen in the anthracite district have been rather restive, and in the event of the miners' organisation agreeing to endorse these new demands there is just the prospect of a little more trouble in the western part of the Welsh coalfield.

Slack Time at Collieries.—It is now officially announced that the South Wales coalowners have supported the recommendation of enquiry that, with the view of obtaining an equitable distribution of trade and thus securing more regular employment at the collieries, a definite system should be adopted for an allocation of orders. When seen last Friday the Coal Controller informed the coalowners' deputation that he had decided to instruct the Local Coal and Coke Supplies Committee to prepare at once for his consideration an allocation scheme on the lines suggested by the Commission of Inquiry, and it is understood that that committee are now engaged in the preparation of a scheme, and that they will meet next Wednesday in order to discuss details.

BY-PRODUCT COKING IN THE UNITED STATES.—The following summary of the coke oven plants with by-product recovery completed on January 1, 1918, is taken from *The Iron Age*, New York:—

Number of plants	54
Number of ovens	7,495
Coal carbonising capacity, tons ...	35,625,000
Coke capacity, tons	26,005,400
Ammonia (as NH3), net tons ...	89,658
Toluol, gallons	11,646,000

The above totals are simply the sums of rated annual capacities of the plants. The outputs given would not necessarily be realised universally, while the ammonia and toluol recovery is not complete at all plants.

GERMAN ASSOCIATION OF TECHNICAL AND SCIENTIFIC SOCIETIES.—The association of various German societies of technical and scientific interest, which was founded in 1916, held its first general meeting last October, under the presidency of Professor C. Busley. The main object is to enable experts from various branches to co-operate in their work, but the questions of reforming the technical training at technical high schools and of securing suitable conditions for the appointment and employment of technologists by the states and public bodies have also been taken up. Another object aimed at is to provide an advisory body for inquiries about technical and scientific tests.

COTTON-PICKING MACHINERY.—The extending cultivation of cotton in Queensland lends special importance to the following: At a recent meeting of the Executive Committee of the Advisory Council of Science and Industry, a special committee was appointed to inquire into the relative merits of various mechanical cotton pickers, and to take steps to develop a picker suited to Australian conditions. Three Australian inventors have already submitted their ideas on this subject to the executive, and the plans proposed by them appear to contain the germs from which a successful machine may be developed. It will be the function of the newly-appointed committee to get in touch with inventors, to help them to work out the mechanical details of their inventions, and to make thorough tests of the machines when constructed. The members of the committee are: Messrs. Norman Bell, A.M.I.C.E. (chairman), Brisbane; P. L. Western, B.Sc., B.E. (lecturer on engineering in the University of Queensland), and Daniel Jones, formerly cotton expert in the Queensland Department of Agriculture.

SIGNALLING AND INTERLOCKING OF KEADBY RAILWAY AND BRIDGE.*

By JAMES BENJAMIN BALL, M.Inst.C.E.

REFERENCE has been made to the signalling question in the author's paper on "Keadby Bridge,"† but in view of the many special features involved in this work, and its probable interest to engineers, a detailed description of the undertaking is presented in the following paper. As the principal engineering feature of the railway is the lifting span of the combined rail and road bridge above referred to, which crosses the River Trent, the signalling problem at this point involved the consideration of three classes of traffic, viz., road, rail and river. Consequently, when the power equipment of the bridge was under consideration, and the necessity arose for putting down a special generating plant in connection with the electrical operation of the lifting span, the question of all-electric signalling was brought to the front. Its adoption enabled the problem to be dealt with in a satisfactory manner, the three classes of traffic being co-ordinated in a general scheme of signalling, bridge bolting and detecting, gate-locking and track-circuiting, the all-electric system being centralised in a 28-lever interlocking frame located in the bridge operating cabin.

This frame is of the automatic indication type with lever-stroke completion. The movement of each lever requires manual operation only during the preliminary part of its stroke. After the completion of the movement in the function to be operated, the stroke is automatically completed, thus indicating that the function has worked correctly. The three-piston upper quadrant signals adopted are the first to be installed in England as a complete scheme. The essential characteristics of three-position signals, as distinguished from lower quadrant signals now in general use, are illustrated in Fig. 4, and are dealt with in detail later.

Among the special features of the work are the installation of an all-electric dynamic indication system for the operation of points and signals, the control of high and low-voltage signals by track circuit with overlap and non-overlapping sections, track-locking and detection of facing points, indication in the cabin of the track-circuited lines, control of certain signals from mechanical cabins, and the electric control of mechanically-worked switch levers; bolt-locking and rail-detection of the lifting span of the bridge is open for river traffic, sand drags are provided on both up and down lines.

In the event of a train running past the signals (the sand drag points being open), it is diverted from the running line into the drag, details of which are shown in Fig. 2, the friction between the rail and the wheels through the sand being sufficient to bring the train to rest without actually derailing it. The signals are lettered on the general diagram to agree with the numerical notation of their levers in the frame, whilst those signals which are controlled from adjacent cabins are denoted by letters.

On the east, the sand-drag points are controlled by lever No. 22, whilst Nos. 27 and 28 are the down inner and outer home signals respectively. The 45 deg. and stop positions of signal No. 27 are controlled from the

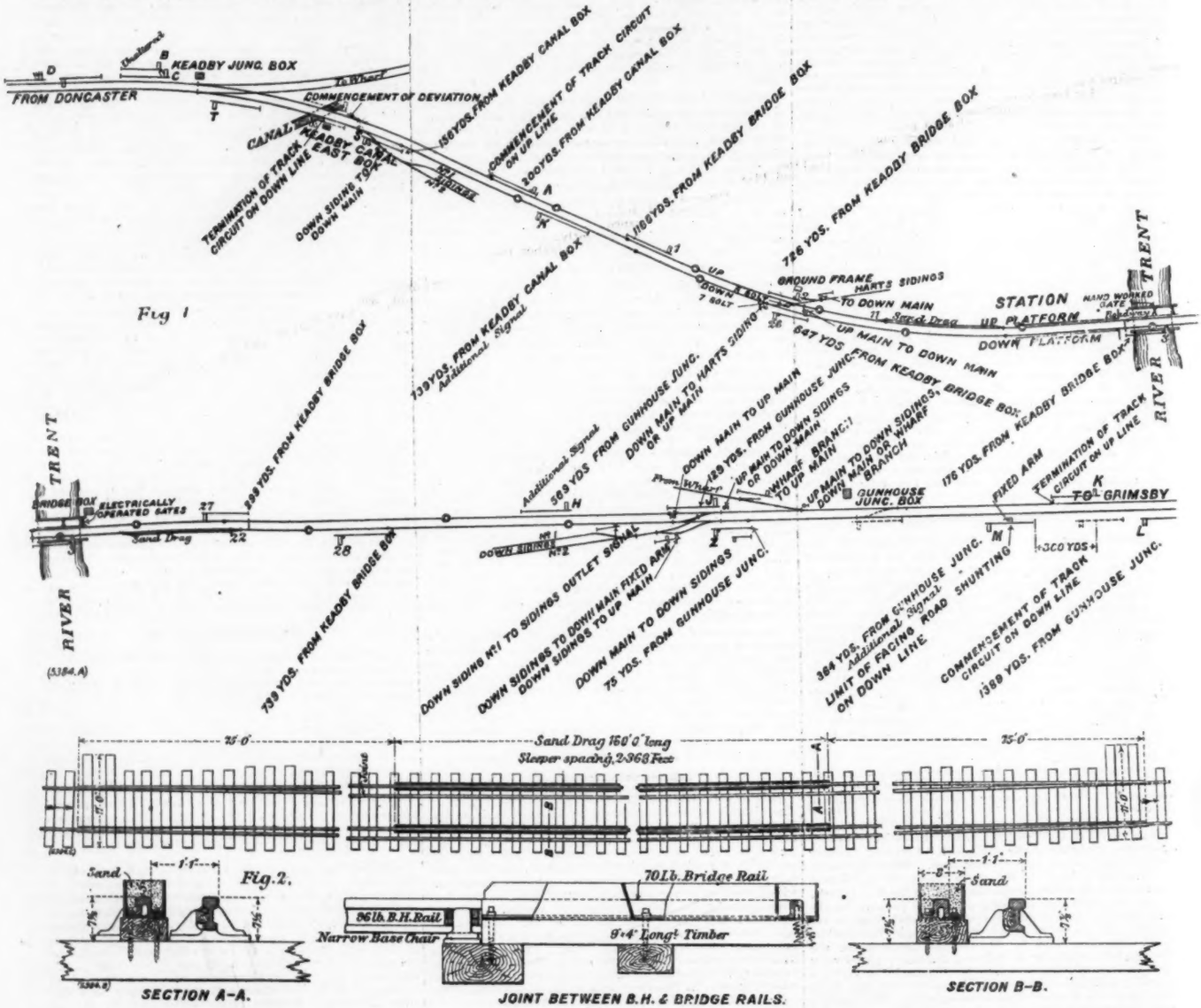

FROM DONCASTER
KEADBY JUNC. BOX
COMMENCEMENT OF DEVIATION
CANAL
KEADBY CANAL EAST BOX
TERMINATION OF TRACK CIRCUIT ON DOWN LINE
DOWN SIDING TO DOWN MAIN
158 YDS. FROM KEADBY CANAL BOX
COMMENCEMENT OF TRACK CIRCUIT ON UP LINE
200 YDS. FROM KEADBY CANAL BOX
1166 YDS. FROM KEADBY BRIDGE BOX
726 YDS. FROM KEADBY BRIDGE BOX
739 YDS. FROM KEADBY CANAL BOX
Additional Signal
GROUND FRAME
HARTS SIDINGS
TO DOWN MAIN
STATION
HAND WORKED GATE
UP PLATFORM
DOWN PLATFORM
UP MAIN TO DOWN MAIN
647 YDS. FROM KEADBY BRIDGE BOX
RIVER TRENT
739 YDS. FROM KEADBY BRIDGE BOX
569 YDS. FROM GUNHOUSE JUNC.
DOWN MAIN TO HARTS SIDING
DOWN MAIN TO UP MAIN OR UP MAIN
DOWN MAIN TO UP MAIN OR DOWN MAIN
129 YDS. FROM GUNHOUSE JUNC.
UP MAIN TO DOWN SIDINGS OR DOWN MAIN
WHARF BRANCH
UP MAIN TO DOWN SIDINGS, DOWN MAIN OR WHARF BRANCH
GUNHOUSE JUNC. BOX
176 YDS. FROM KEADBY BRIDGE BOX
FIXED ARM
TERMINATION OF TRACK CIRCUIT ON UP LINE
TO GRIMSBY
BRIDGE BOX ELECTRICALLY OPERATED GATES
Sand Drag
DOWN SIDING No. 2
DOWN SIDING No. 1 TO SIDINGS OUTLET SIGNAL
DOWN SIDINGS TO DOWN MAIN FIXED ARM
DOWN SIDINGS TO UP MAIN
DOWN MAIN TO DOWN SIDINGS
75 YDS. FROM GUNHOUSE JUNC.
364 YDS. FROM GUNHOUSE JUNC.
Additional Signal
LIMIT OF FACING ROAD SHUNTING
300 YDS
COMMENCEMENT OF TRACK CIRCUIT ON DOWN LINE
1389 YDS. FROM GUNHOUSE JUNC.
(5384.A)

Fig 1

* Paper read before the Institution of Civil Engineers and reproduced by permission from the Minutes of Proceedings.

† Minutes of Proceedings, Inst.C.E., vol. cciii, page 33. See also ENGINEERING, vol. civ.

The signalling control extends from Canal Junction on the west side of the River Trent to Gunhouse Junction on the east side, a distance of nearly 2¼ miles. Both up and down lines are track-circuited, including the portion of the track on the lifting span, and suitably divided into the desired sections for the control of signals and track-locking of points, the whole of the track circuits being indicated in the cabin.

The bridge is approached by rising gradients of 1 in 270 on the west, and 1 in 200 on the east side. As a protection against over-running of the signals when the cabin and by the track circuit between it and the west end of the overlap beyond starting signal No. 26, and the 90-deg. position is controlled by the starting signal in the 90-deg. position. The 45-deg. and stop position of No. 28 is controlled from the cabin and by overlap track circuit to the west end of the platform, and the 90-deg. position by the inner home signal No. 27, in the 45-deg. or 90-deg. position. The signal marked "Z" on the diagram is the starting signal for Gunhouse Junction, and is operated on by a circuit-closer on a mechanical lever in that cabin, and controlled in the 45-deg. position by track circuit to the inner home signal No. 27, and in the 90-deg. position by sand-drag points No. 22 normal, both signals 27 and 28 being in the 45-deg. or 90-deg. positions. An electric lock controlled by the track is provided on this signal lever to prevent its operation should the track be occupied between this signal and the inner Home No. 27, the object being to prevent the release of the mechanical distant signal lever with signal "Z," at "danger," but its lever reversed. Signal "Z," which is not controlled from the bridge cabin but from the Gunhouse Junction box, is for economical reasons a

low-voltage operated signal, the movement being worked from a small accumulator at the base of the post. A signal repeater is provided to show its operation, and the track circuit to the inner home signal No. 27 is indicated in Gunhouse Junction cabin.

On the west side of the river, the 45-deg. and stop positions of the down starting signal No. 26 are controlled from Keadby Bridge cabin, and by track circuit to the down inner home signal at Canal cabin, and the 90 deg. by a relay operated from the Canal cabin, and energised by the lowering of signals R, S, T and U. On the up line, sand-drag points No. 11 are provided to give protection similar to that previously described with reference to No. 22. A cross-over road and a connection to Hart's siding are worked by levers in a mechanical ground frame controlled by electric locks released from the bridge cabin by levers 7 and 8 respectively. Lamp indicators at the ground frame are provided to show when a release has been given.

On the up line, a low-voltage signal A is the starting signal for the canal cabin, and its control is similar to that described for signal "Z" on the down line. The 45-deg. and stop positions are controlled from Canal box, and by track circuit to inner home signal No. 2, and the 90-deg. position by sand-drag points No. 11 normal, both signals Nos. 1 and 2 being in the 45-deg. or 90-deg. position. The 45-deg. and stop positions of outer home signal No. 1 are controlled from the cabin and by overlap track circuit to the starting signal No. 3, and the 90-deg. position is dependent on signals 2 and 3 being in the 45-deg. or 90-deg. position. The 45-deg. and stop positions of the inner home signal No. 2 are controlled from the cabin, and by overlap track circuit to a point 440 yards east of starting signal No. 3, and the 90-deg. position by signal No. 3 being at 45 deg. or 90 deg. The starting signal No. 3, 45-deg. and stop positions are controlled from the cabin and by track circuit to Gunhouse Junction inner home signal, and the 90-deg. position by the operation of a relay from Gunhouse Junction cabin energised by the lowering of signals H, J and K.

The controlling arrangements for the lifting span of the bridge are necessarily of a complicated nature, for the reason that it has to be bolted at the nose end and the correct alignment and level of its rails with the rails on the fixed spans ensured by their being plunged at right angles and detected, both at the nose and heel, before rail or road traffic can pass over the bridge. Nos. 16 and 17 are the rail-detector levers for the west and east ends of the bridge; No. 18 is the bridge-bolt.

For the protection of the road traffic a pair of electrically-worked gates are provided at the east side of the bridge (Fig. 3), and on the west side one hand-worked single gate. The reason for the provision of a hand-worked instead of an electrically-operated gate on this side was owing to the prevalence of fog at certain seasons of the year, which would render the safe working of road traffic somewhat problematical if controlled entirely from the bridge cabin, the distance from the west gate therefrom being about 200 ft. The gates on both the east and west sides are locked or released by stops electrically controlled from the cabin by lever No. 15. Road-warning signals (lever No. 14) are given from the cabin by means of electric bells on the road approaches at each end of the bridge. The cabin controls the operation of signals (lever No. 5) for the conduct of river traffic by a special arrangement and location of lights (as shown in Fig. 3), certain of these lights changing to different colours to indicate to ships at night the position of the lifting span either "up" or "down." In the daytime a hand-worked ball signal is used for the same purpose.

The normal position of the lifting span is down, *i.e.*, "right" for the railway and road traffic. The sand-drag points No. 11 and 22 are in their normal position for running lines, the bridge-bolt is in, and the rails plunged, allowing under these conditions the signalled movements across the bridge and the approach of trains from either direction, in addition to vehicular and pedestrian traffic.

To open the bridge for river traffic the following sequence of movements of the levers above-mentioned takes place, ensured by ordinary interlocking. The road-warning lever No. 14 is pulled, causing a bell to ring at each of the warning signs. This bell continues to ring until the gates are nearly closed across the road-way, when the circuit is interrupted, and the ringing ceases. These signs are illuminated at night, displaying the word "Danger." Lever No. 15, released by No. 14, is then pulled to operate the gate stops and release the electrical operating lever in the signal cabin to allow the gates (east) to be worked. A bell is also rung at the gateman's hut as an indication to the gateman to close his gate. Each gate now being in its reversed position across the roadway, the gate contacts are made, and the east gate controller lever being put back to its normal position, an automatic return indication movement is given to lever No. 15 as an assurance of correct working.

Sand-drag levers Nos. 11 and 22 are then pulled, thereby opening the points to the sand drags in the up and down roads in the facing direction of traffic on each side of the bridge, and an automatic return indication movement given on their levers denoting the correct working of the points. This effects the release of levers No. 16 and 17, which, on being pulled, operate the rail-detector at the east and west ends of the lifting span. The rail plungers are withdrawn from the rail-ends, and such withdrawal electromechanically detected. At the same time the contacts of the bridge-circuit closers are broken. The correct working of the operative connections having been obtained, indication is given to levers Nos. 16 and 17 by the automatic completion of their stroke.

As soon as the levers Nos. 16 and 17 have been correctly worked, a release is effected on the bridge-bolt lever No. 18. This lever when pulled makes suitable contact to allow the current to operate a series of clapper switches at the cabin, through the contacts of which current passes to the motor for withdrawal of the bridge-bolt. The proper working of the operative parts having been ensured, a return automatic indication movement is given to the operating lever No. 18.

The last operation necessary before the actual bridge-operating mechanism is free to be used is the pulling of a king lever, No. 19. This lever is released by the proper working of lever No. 18, previously described, and when pulled, energises a relay, through the contacts of which the high-voltage current (220 volts) for working the bridge motors passes to the clapper switches of the master controller; at the same time an electric lock on the master-controller handle is released, so freeing the latter for the operation of the bridge through the dependent mechanism described in the "Keadby Bridge" paper. Immediately the controller handle is moved from the normal position the king lever is locked in its pulled position, thus providing the necessary interlocking between the frame and the bridge-operating gear.

Before the interlocking frame can again be brought into use, lever No. 19 must be restored to its normal position, and this can only be accomplished when the leaf is down on its bearings and a contact on the extreme point of the lifting span is closed in series with other contacts on the lock in the master controller. The function of the latter contacts is to ensure that the controller is locked in its normal position. To lower the bridge for normal traffic, the sequence of movements of the above-mentioned levers is reversed.

Three-Position Signals.—The use of three-position upper quadrant signals presents many interesting features, and the following is a short description of their mechanism and control: Referring to Fig. 4, each signal works to three positions in the upper quadrant, which is sound practice, as gravity exerts its force to bring the arm to the "danger" or "stop" position in the event of any disconnection of electric control or breakage of operating connections.

The horizontal position, and a red light at night, indicates "stop."

The intermediate or 45-deg. position, and a yellow light at night, means "Proceed, prepared to stop."

The vertical, or 90-deg. position, and a green light at night, means "proceed."

It will be seen, therefore, that three distinct instructions are given to the driver by the use of one arm, the position of each arm at 45 deg. being governed by the signal cabin and track circuit and the signal ahead at the "stop" position. The 90-deg. position is automatically assumed when the signal or signals ahead are at the 45-deg. or 90-deg. position. The governing of the different positions of the signals A, 1, 2 and 3 has been already referred to. Signals A and Z not being controlled from Keadby Bridge cabin, low-voltage signal move-

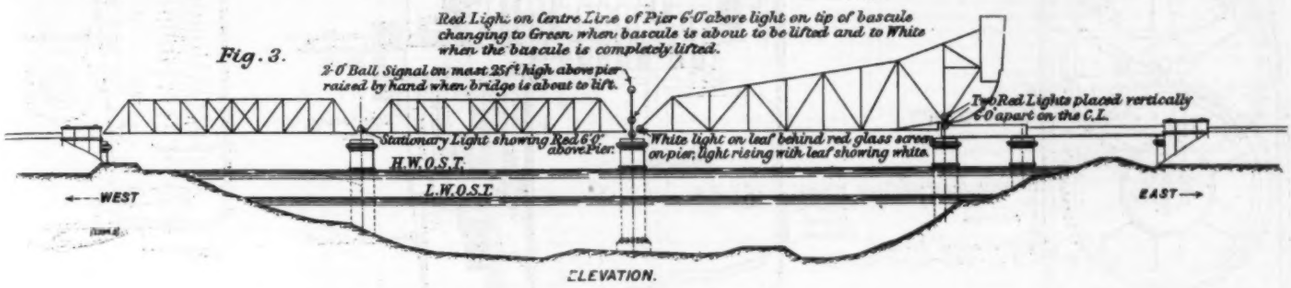

Red Light on Centre Line of Pier 6'0" above light on tip of bascule changing to Green when bascule is about to be lifted and to White when the bascule is completely lifted.
2'0" Ball Signal on mast 25ft. high above pier raised by hand when bridge is about to lift.
Two Red Lights placed vertically 6'0" apart on the C.L.
Stationary Light showing Red 6'0" above Pier.
White light on leaf behind red glass screen on pier, light rising with leaf showing white.
H.W.O.S.T.
L.W.O.S.T.
WEST
EAST
ELEVATION.

Fig. 3.

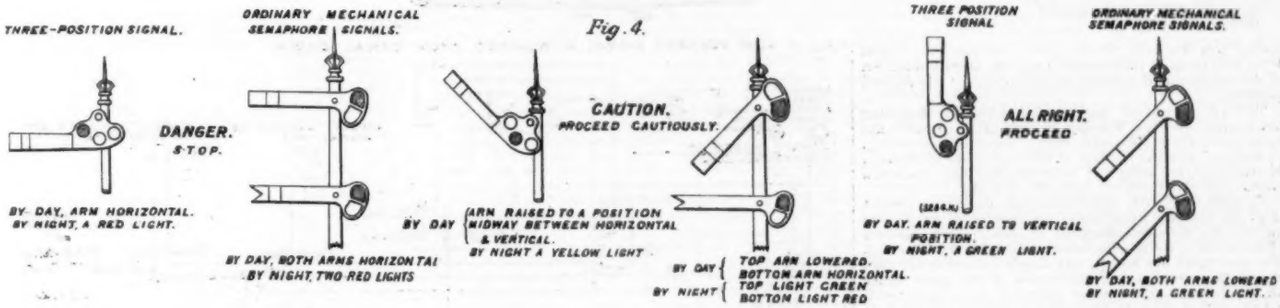

THREE-POSITION SIGNAL.
DANGER.
STOP.
BY DAY, ARM HORIZONTAL.
BY NIGHT, A RED LIGHT.
ORDINARY MECHANICAL SEMAPHORE SIGNALS.
BY DAY, BOTH ARMS HORIZONTAL
BY NIGHT, TWO RED LIGHTS
CAUTION.
PROCEED CAUTIOUSLY.
BY DAY { ARM RAISED TO A POSITION MIDWAY BETWEEN HORIZONTAL & VERTICAL.
BY NIGHT A YELLOW LIGHT
BY DAY { TOP ARM LOWERED. BOTTOM ARM HORIZONTAL.
BY NIGHT { TOP LIGHT GREEN BOTTOM LIGHT RED
THREE POSITION SIGNAL
ALL RIGHT.
PROCEED
BY DAY, ARM RAISED TO VERTICAL POSITION.
BY NIGHT, A GREEN LIGHT.
ORDINARY MECHANICAL SEMAPHORE SIGNALS.
BY DAY, BOTH ARMS LOWERED
BY NIGHT, A GREEN LIGHT.

Fig. 4.

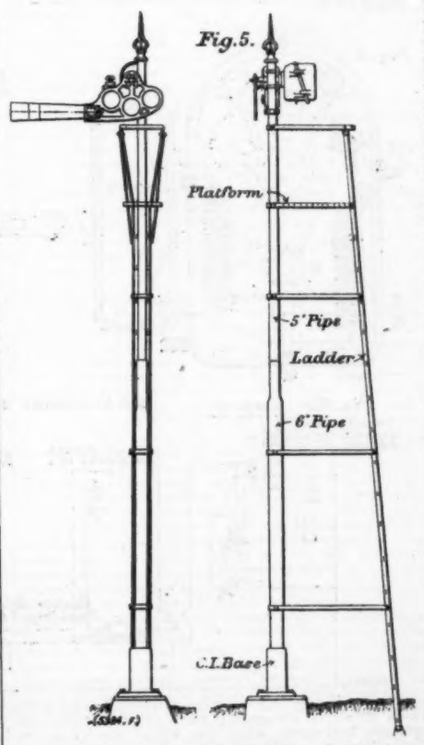


Fig. 5.

ments are used. The only differences between these low-voltage machines and the 110-volt machines used in connection with all signals controlled by the bridge cabin are in the motor, and the elimination of the device for generating dynamic indicating current after a signal arm has been returned to "danger," the signal lever still being in the reversed position, and the addition of special means of holding the signal arm in the desired position.

The two types of high and low-voltage top-mast mechanism used at Keadby Bridge (Fig. 5) have the same general outside appearance. The cast-iron casing, or housing, and the method of attachment to post, train of gears, driving shaft and coupling, spectacle shaft and circuit controller are all common to both.

Dealing first with the low-voltage signal movement (Fig. 6) and its application to signals A to Z, the mechanism has been designed to obtain great freedom of operation in the gearing between motor and movement. The gear-teeth are heavy, and ample clearance between the teeth ensures a free movement of the gears under all conditions. The motor operates in a dust-proof casing, and is directly connected to the spectacle shaft by means of the train of gears placed in the compartment at the back of the case; a special coupling allows for any variation in the alignment of the driving and spectacle shafts, and also provides effectual locking of the signal arm in the "stop" position to prevent any unauthorised movement. The direct-current motor in this, and also the 110-volt type, presents a common feature for checking the motion of the signal arm. The signal arm, when going from the 90-deg. to the "stop" position, causes the motor to rotate in the reverse direction, thereby generating a current which very effectively checks the motion of the signal arm when the motor is shunted through a snubbing resistance just before the arm comes to the "caution" or "stop" position. A friction clutch between the motor and its driving pinions protects the motor and gearing from the effects of sudden strain. A device contained in a casing forming part of the clamp bearing serves as a shock-absorber, and affords means of a proper signal adjustment.

The circuit controller B, shown in Fig. 6, is an important part of the signal mechanism through which the motor and signal circuits are controlled. It consists of a frame carrying a specially-treated hardwood cylindrical drum on which contact plates are mounted; adjustable contact fingers, with an attachment for locking them in proper position, an attachment for producing snap contacts when required, and segmental gears by means of which the movement of the main shaft is transmitted to the circuit controller.

The motor is of the four-pole series-wound type. A retaining device for holding the signal in the 45-deg. or 90-deg. position is shown in Fig. 7. Fig. 8 shows the general arrangement of circuits for signal A, with the method of its operation from the Canal cabin by means of a circuit-closer on a mechanical lever and its control by a repeater track relay and 90-deg. position control by a repeater relay at the signal, which relay is governed by track relays and signals 1 and 2. The track-circuit repeater relay is wired as a stick relay through a lever contact to ensure that, after the signal has been put to "stop" and a train has passed clear of the track circuits governing the signal, the signal will not clear again automatically. The stick relay governing the operating circuit will not pick up until the signal lever has been put back and the track cleared.

The 110-volt top-mast mechanism (Fig. 9) is used for Keadby Bridge cabin signals 1, 2, 3, 26, 27 and 28. This mechanism is provided with a four-pole series-wound motor, but differs from that of the low-voltage movement, inasmuch as the armature constitutes the means for holding the signal in the 45-deg. or 90-deg. positions. The surfaces of two of the pole pieces are serrated so that, when the holding field windings are energised, the magnetic attraction between these two-pole pieces and the armature prevents rotation of the armature in either direction and holds the signal in the desired position. The high resistance of these windings reduces the current to a minimum. A dynamic indication-current is generated by the over-run of the motor when the signal is returned from the 45-deg. or 90-deg. to the "stop" position for the purpose of completing the return stroke of the operating lever in the cabin, which feature is specially described hereafter. When a train has entered a track section governed by the signal, the track relay is de-energised, thereby breaking the operating and holding circuits of the motor and the signal arm returns to the "stop" position. A spring attachment is used in connection with the driving shaft, which stores up the energy necessary to produce the dynamic indication, when the signal arm is in the "stop" position. The coupling between the driving shaft and the signal arm has an initial free movement, during which the springs are put into tension, after which the arm commences to move to the "proceed" position. On returning the arm to the "stop" position, if the lever has not been put back by the signalman, the energy stored up in the spring is retained until this is done by him, when it is released to produce the power necessary for the indication. These springs have no effect in restoring the signal arm to the "stop" position.

In both the mechanisms described in Figs. 6 and 9 friction clutches are provided between the motor and its pinion, and to prevent injury to the motor in the event of any derangement of the circuits, a safety device consisting of a pawl and ratchet-wheel arrangement in combination with a brake is fitted between the second intermediate wheel "F" and its pinion "G." Fig. 10 shows the general arrangement of circuits for signal No. 1, the 45-deg. and "stop" positions being controlled from the cabin and track relays, and the 90-deg. automatically through the circuit controllers on signals 2 and 3. This circuit is typical of the other signals controlled from this cabin.

(To be continued.)

Fig. 6. LOW VOLTAGE SIGNAL MOVEMENT. TOP MAST MECHANISM.

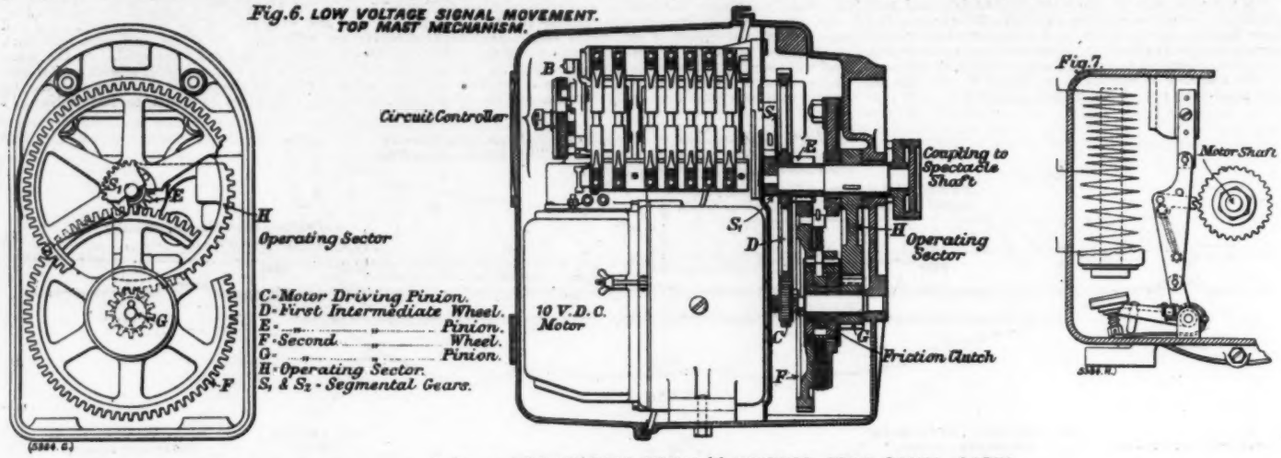


Fig. 7.

Fig. 8. LOW VOLTAGE SIGNAL 'A' WORKED FROM CANAL CABIN.

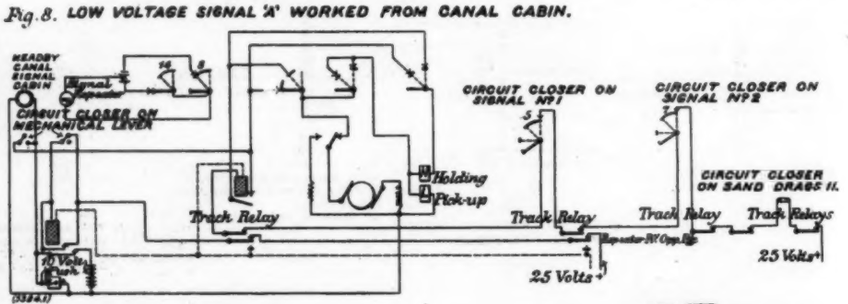


Fig. 9.

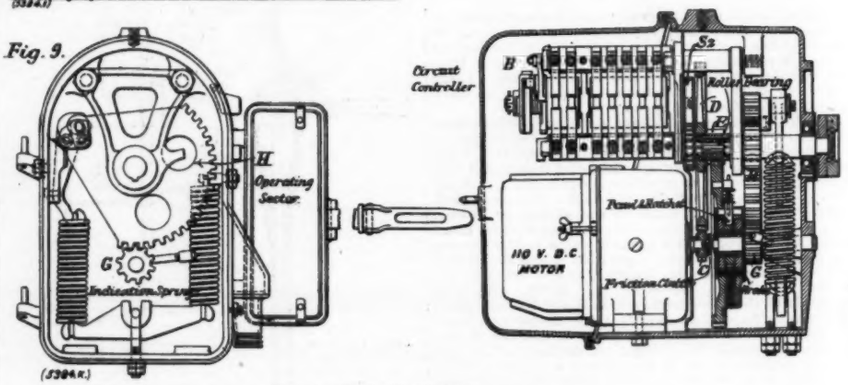
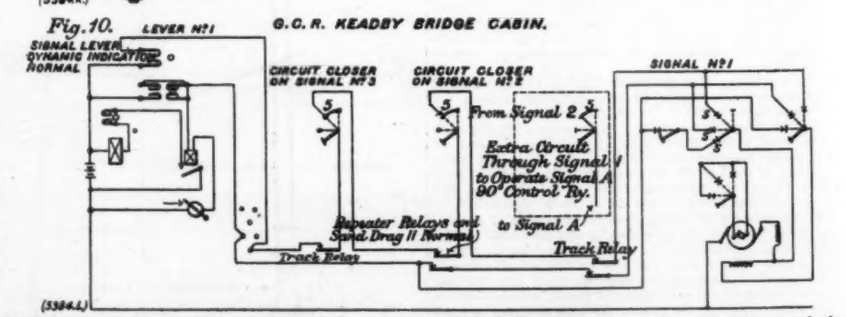


Fig. 10. LEVER N°1 G.C.R. KEADBY BRIDGE CABIN.


SIGNAL LEVER DYNAMIC INDICATION NORMAL
CIRCUIT CLOSER ON SIGNAL N°3
CIRCUIT CLOSER ON SIGNAL N°2
SIGNAL N°1
From Signal 2
Extra Circuit Through Signal 1 to Operate Signal A 90° Control Rly.
Repeater Relays and Spnd. Drag II Normal
to Signal A
Track Relay
Track Relay

THE SWEDISH BALL-BEARINGS INDUSTRY.—Sweden seems to have made a speciality of the manufacture of ball bearings, no doubt owing to the success which has attended the first venture. There are now no less than eight ball-bearing companies in Sweden, of which, however, only two are in regular working, but several of the others are strong concerns, likely to make their mark. The oldest company, the Swedish Ball-Bearings Company, which started in 1907, has again increased its capital, so that it now amounts to 84,000,000 kroner.

BRITISH STANDARD SECTIONS FOR SHIPBUILDING AND CONSTRUCTIONAL PURPOSES.

WE have received from the Controller of Iron and Steel Production the following approved lists of British standard sections for shipbuilding, constructional and other general purposes :—

Angles, Equal—	Thicknesses. Min.	Max.
In. In.	In.	In.
1 by 1	0.125 to	0.25
1½ by 1½	0.125 to	0.50
2 by 2	0.125 to	0.50
2½ by 2½	0.187 to	0.50
3 by 3	0.25 to	0.75
3½ by 3½	0.30 to	0.75
4 by 4	0.35 to	0.75
5 by 5	0.375 to	0.75
6 by 6	0.375 to	1.00
8 by 8	0.50 to	1.00*

* Seldom rolled.

Angles, Unequal—		
2½ by 1½	0.125 to	0.50
2½ by 2	0.187 to	0.50
3 by 2	0.187 to	0.50
3½ by 2½	0.25 to	0.75
4 by 3	0.30 to	0.75
5 by 3	0.35 to	0.75
6 by 3½	0.375 to	0.75
7 by 3½	0.375 to	0.75

Most of the small sections are available in shell discard, and the mills should be given the option of supplying this quality where practicable.

Bulb Angles—	Thicknesses. Min.	Max.
In. In.	In.	In.
5 by 2½	0.30 to	0.55
6 by 3	0.35 to	0.60
7 by 3	0.35 to	0.60
8 by 3	0.40 to	0.65
9 by 3½	0.45 to	0.70
10 by 3½	0.50 to	0.75
11 by 3½	0.50 to	0.75
12 by 3½ (or 12 by 4)	0.50 to	0.75

(Available as required.)

Bulb Plates—		
7½ in. deep	0.35 to	0.60

Tees, Equal—			
In.	In.	In.	In.
1½ by	1½ by	$\frac{3}{16}$	and ¼
1½ by	1½ by	$\frac{1}{8}$	and ¼
1½ by	1½ by	$\frac{1}{16}$	and ¼
2 by	2 by	¼, $\frac{5}{16}$,	⅜
3 by	3 by	⅜	and ½
4 by	4 by	⅜	and ½

Tees, Unequal—			
In.	In.	In.	In.
1½ by	2 by	¼	and $\frac{1}{16}$
5 by	3 by	⅜	and ½
6 by	3 by	⅜	and ½
7 by	3½ by	½	and ⅝*

* Seldom rolled.

Most of the small sizes are available in shell discard, and the mills should be given the option of supplying this quality where practicable.

Channels.	Thicknesses. Min.	Max.
In. In.		
3 by 1½ ...	0.25-in. to 0.35-in. web. by 0.3125-in. flanges.	
4 by 2 ...	0.25-in. to 0.35-in. web by 0.375-in. flanges.	
5 by 2½ ...	0.3125-in. to 0.40-in. web by 0.375 flanges.	
6 by 3 ...	0.375-in. to 0.475-in. web by 0.50-in. flanges.	
6 by 3 ...	0.3125-in. to 0.40-in. web by 0.375-in. flanges.	
7 by 3 ...	0.375-in. to 0.50-in. web by 0.50-in. flanges.	
8 by 3 ...	0.375-in. to 0.50-in. web by 0.50-in. flanges.	
9 by 3 ...	0.375-in. to 0.50-in web by 0.4375-in. flanges.	
9 by 3½ ...	0.50-in. to 0.625-in. web by 0.60-in. flanges.	
9 by 3½ ...	0.375-in. to 0.50-in. web by 0.50-in. flanges.	
10 by 3½ ...	0.475-in. to 0.60-in. web by 0.60-in. flanges.	
10 by 3½ ...	0.375-in. to 0.50-in. web by 0.50-in. flanges.	
12 by 3½ ...	0.50-in. to 0.625-in. web by 0.60-in. flanges.	
12 by 3½ ...	0.375-in. to 0.50-in. web by 0.50-in. flanges.	
15 by 4 ...	0.525-in. to 0.65-in. web by 0.63-in. flanges.	

Joists—			
In.	In.		
3 by	1½ by 4	lb. per ft.-min.	
4 by	3 by 9½	,,	,,
4½ by	1½ by 6½	,,	,,
5 by	3 by 11	,,	,,
6 by	3 by 12	,,	,,
6 by	4½ by 20	,,	,,
6 by	5 by 25	,,	,,
7 by	4 by 16	,,	,,
8 by	4 by 18	,,	,,
8 by	5 by 28	lb. per ft.-min.	
8 by	6 by 35	,,	,,
9 by	4 by 21	,,	,,
10 by	5 by 30	,,	,,
12 by	5 by 32	,,	,,
12 by	6 by 44	,,	,,
14 by	6 by 46	,,	,,
15 by	5 by 42	,,	,,
16 by	6 by 62	,,	,,
18 by	7 by 75	,,	,,
20 by	7½ by 89*	,,	,,

* Seldom rolled.

Sections up to and including 9 in. by 4 in., except 7 in. by 4 in. and 8 in. by 4 in., are rolled almost exclusively in shell discard quality, and if these sections are specified, that quality should be accepted. Certain of the larger sections are also rolled occasionally in shell discard, and works should be given the option of supplying in that quality where practicable.

In addition to the above, trawler keel bulbs, 7½ in. by 1½ in. to 1½ in., are obtainable.

GERMAN INDUSTRIAL ACTIVITY.

EXPANSIONS, combinations and new undertakings are still of common occurrence in Germany, the leading principle apparently being the one of the large concerns swallowing up the small ones.

Thus the German Potash Works Company (Deutsche Kaliwerke) have acquired the three concerns owning the Bernburger works, the Gröna works, and the Erbprinz works. The purchase is to be paid for by 6,150,000 marks of new shares in the German Potash Works. A further 4,400,000 marks of new shares will be required for the acquisition of the Britania, the Wilhelmine and the Hedwig concerns. The Immenrode concerns are likely to accept an offer made by the German Potash Works of three new shares for each portion (kux), and further absorptions are not unlikely to take place. The amount of the new share issue has not yet been decided upon, but it will not exceed the aggregate purchase money of the new acquisitions. It seems to be the general opinion that the different concerns referred to above will have decidedly better chances as parts of the large company, than they have as separate and individual undertakings. It has been stated in authoritative quarters that the reports issued, showing very large profits on the export trade, were exaggerated, although foreign countries had paid higher prices than the home market. The reports concerning an amalgamation, or some kind of a combine, between the Potash Works and the huge aniline combine had, it would appear, no foundation in fact. The high prices ruling at present for shares in potash concerns naturally rendered the acquisitions referred to above more expensive, but at the same time it was thought that they might help to frustrate any State monopoly scheme as far as the particular industry was concerned.

The Aniline or Dye Works Combine has in the meantime acquired all the shares of the Rudolf Wedekind Company for chemical industry.

The Hirsch Copper Works have been particularly busy in striking out on new lines and extending their field of operations during the war, aided by the remunerative results of their business proper. The Hirsch Company have taken over a considerable interest in the Bavarian Neumeyer iron works, and are also one of the founders of the Kursaxe Company, a power concern, in connection with which the Hirsch Company are contemplating the erection of works. The Hirsch Company have also invested considerable sums in the Bavarian graphite industry, in connection with which further large outlays of capital will be called for. It will be necessary to increase the present capital, of 15,000,000 marks, by 7,500,000 marks, or probably more, inasmuch as it has now transpired that the Hirsch Company are also contemplating the acquisition of the Reinickendorf brass works, the other portion of the latter concern, the Hönninger Chemical Works having been disposed of to the Rhenania Company for some 10,000,000 marks in cash. This will mean, it is stated, a drag upon the Hirsch Company, as far as their business proper is concerned, since the company already own works at Eberswalde, Ilsenburg, and Neukölln, together with the recent acquisition at Neumeyer, near Nüremberg. The scope of the metal industry has certainly expanded much during the war, but this expansion may only be temporary, and as far as copper is concerned, its future seems very uncertain, owing to all the substitutes which have been introduced since the war; several large works have adopted aluminium and are preparing for using this on a large scale, and Germany as a whole is preparing to manufacture it extensively at an increasing number of large works. The Hirsch Company are understood to be contemplating taking also an increased interest in the aluminium industry, and their acquisition of the Reinickendorf concern is likely to bring them into closer touch with the Metal Bank and Metallurgical Company, which connections would mean increased activity in aluminium production.

Special endeavours are being made on the part of the important iron works to increase their holdings in coal mines; large deals have taken place and several other large ones are pending. There are, as a rule, several prospective buyers when a coal mine comes into the market. Negotiations are at present pending concerning the Trier I, II, III mines, with regard to the purchase of which the city of Berlin was negotiating some little time ago; the deal, however, fell through. The same may be said concerning the Hermann I, II, III mines and the Admiral mine, which are also on the market. The latter was on the point of being sold to Sweden, when the German Government interfered. Negotiations are also proceeding in respect to the Graf Schwerin coal mine.

Within shipping and shipbuilding circles much activity is also noticeable. The great coal and mining firm of Hugo Stinnes have lately manifested much interest in shipping, and the firm have now formed a new shipping company, the Hugo Stinnes Company for Shipping and Overseas Commerce, in Hamburg. The capital for the present is only 5,000,000 marks, but there is, of course, plenty of capital at the back of the deal, and the programme is fairly comprehensive, namely, all classes of shipping, and also the production of commodities, both at home and abroad, mining and metallurgical industries, chemical and electrical industries, trade in and storage of products, more especially with a view to importing from, and exporting to, foreign countries. The company have the right to establish undertakings abroad, and are to endeavour to establish also connections with other similar undertakings abroad.

In order further to forward German shipping after the war, a special loan bank for shipping is to be formed in Berlin, on similar lines to those governing the one in Hamburg; the two large banks, the Dresdner Bank and the National Bank for Germany are interested in the new venture, with regard to the results of which some amount of scepticism has been manifested.

RETAIL PRICE OF PETROL AND LAMP OIL.—The Board of Trade has made an Order under the Defence of the Realm Regulations limiting the retail price of all grades of motor spirit to 15 per cent., or a maximum of 5*d.* per gallon, above the cost of the spirit to the retailer. The Order also limits the price of lamp oil to 4*d.* per gallon above its cost to the retailer. The price of petrol has for some time been strictly limited to 15 per cent. above the wholesale price by an agreement between the importers and the Motor Traders' Association, but it is obvious that as the wholesale price increases the 15 per cent. without any limit such as that fixed by the Order tends to give an excessive profit to the retailer. In the lamp-oil trade there is no fixed agreement between the wholesaler and the retailer, and the Board of Trade has been informed of cases in which as much as 2*s.* 8*d.* per gallon has been charged for paraffin, which would give a profit of nearly 90 per cent. The new Order takes effect on March 1, and from that date no retailer will be able to charge more than 5*d.* per gallon for petrol or 4*d.* per gallon for lamp oil above the cost of these products as delivered to him.

TESTING REFRACTORIES UNDER LOAD.—A gas furnace for testing refractory materials at temperatures up to 1,500 deg. C. and under loads of 100 lb. per square inch, in use at the laboratories of the H. Koppers Company and the Pittsburgh By-Product Coke Company, is illustrated by R. J. Montgomery in *Metallurgical and Chemical Engineering*, of January 1, 1918. It is a cylindrical brick furnace, about 40 in. in diameter and 33 in. high outside; the two burners, which are fed with gas and compressed air, are so placed tangentially inside the furnace that a whirling flame is produced; the combustion gases are drawn off downward through a hole in the furnace bottom. Two specimen bricks can be tested at the same time. While under test they are each covered by a cup of refractory material; this cup will stand the highest temperature obtainable, though not for many tests. Each cup is attached to a vertical rod which passes through the top of the furnace to a pivoted balance beam which is loaded; a drum recorder is fitted to the beam. Temperatures are taken with the aid of a pyrometer. The rods are not exposed to the flames, being protected by the cups. With the framing the furnace occupies a little more than a square of 5 ft. of floor space.

"PYREKS" HEAT INDICATOR COMPOUND.—Our attention has been called to this compound, consisting of calibrated metallic salts which melt and solidify at different temperatures, and are used in combination with small spoon-shaped receptacles made from a patent non-scaling and rapid heat-conducting alloy called "Reactal." For hardening cobaltcrom tools which have to retain keen cutting edges and are not subject to shock, 1,000 deg. C. "Pyreks" is used, and 900 deg. C. "Pyreks" for tools which are subject to a severe shock, these two temperatures being the correct treating heats for these classes of tools. The compound is also prepared and calibrated for other temperatures. The tool to be hardened is heated uniformly in the muffle to a cherry red; the "Reactal" spoon containing the "Pyreks" is then inserted and placed on or alongside the tool. When the compound becomes quite liquid, the gas or blast is turned off, or, as an alternative, the tool with the spoon is slightly withdrawn towards the cooler zone at the muffle opening. The "Pyreks" is then watched, and when it begins to re-solidify the tool is taken from the muffle and exposed to still air, thus completing the hardening operation. The compound gives equally satisfactory results by using a smith's hearth and making an improvised muffle by inserting in the fire a tube closed at one end or a small plumbago crucible. This heat-controlling device is due to the inventor of cobaltcrom steel; it replaces a pyrometer installation, and cobaltcrom steel tools treated with it have a greatly enhanced staying power; the increased efficiency has been proved to be as high as 50 per cent. A feature of the treatment is that the tools should remain in the muffle and be subjected to a slightly falling heat prior to being exposed to natural air-cooling. The operation of hardening can be seen at the works of Messrs. Darwin and Milner, Limited, Sheffield.

PAINT AND VARNISH SPRAYING PLANT.

CONSTRUCTED BY THE AEROGRAPH COMPANY, LIMITED, ENGINEERS, LONDON.

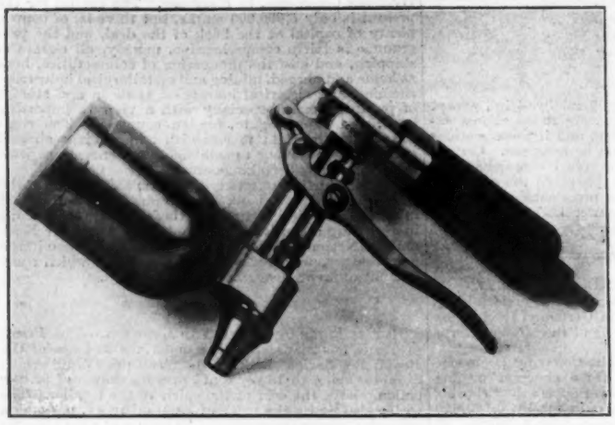


Fig. 1.

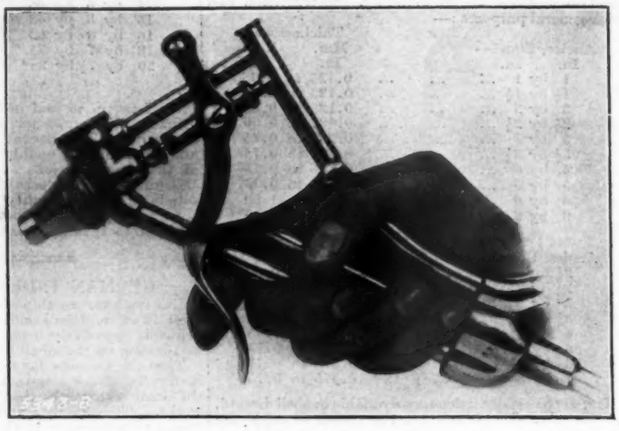
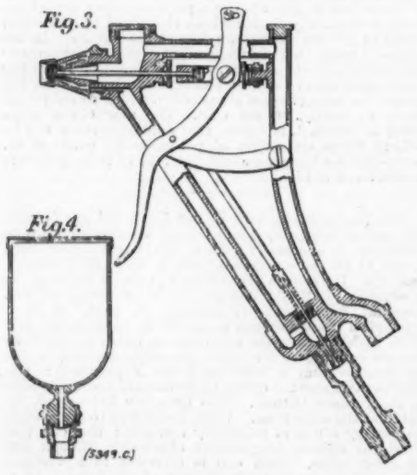


Fig. 2.



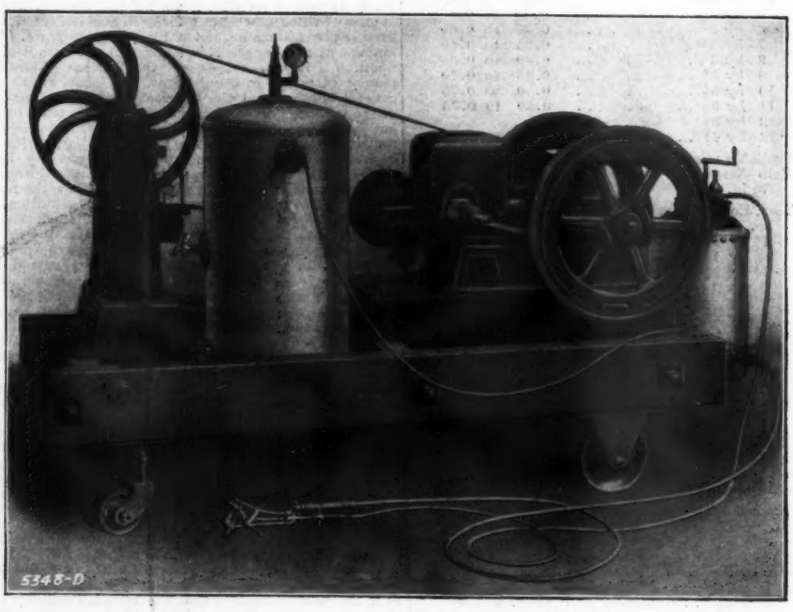


Fig. 5.

The advantages of the spraying process for covering surfaces of all kinds with paints or other pigments is now widely recognised, and we illustrate on this page paint-spraying plant constructed by the Aerograph Company, Limited, of 43, Holborn Viaduct, London, E.C. 1. Two forms of hand sprayers are illustrated by Figs. 1 and 2 respectively. In the case of Fig. 1, the receptacle for the pigment fits on to the side of the spraying pistol, being so mounted that it can be turned to make any angle with the axis of the spray, thus rendering it easy to use the tool either for work on a table or a ceiling, or on the walls of a building. Fig. 2 represents another form of spraying pistol suitable for use in cases in which large areas are to be covered. In this case the liquid to be sprayed is supplied under pressure from a large reservoir through a flexible pipe coupled up to the shank of the tool. For small work the same tool can be used, a paint pot shown in section in Fig. 4 being then screwed to the seating which is to be seen at the top of the pistol in Fig. 3. This represents a section through the tool, and shows clearly its construction. The air supply is admitted through the lower of the two couplings shown, the paint being supplied under pressure through the upper one. The air is controlled by a pin valve, on opening which, by the pressure of the fingers, air passes up the pipe shown to a conical jacket which surrounds the pigment nozzle. As it escapes from the muzzle of the pistol, this air catches up and converts into a fine spray, the pigment simultaneously admitted through the inner nozzle. This also is closed by a needle valve, and is opened and closed simultaneously with that controlling the air supply. The rate at which the paint is fed can be controlled by varying the pressure over it in the receiver from which the supply is derived. This receiver is fitted with a special valve enabling the pressure to be adjusted accurately to the conditions of use.

A complete portable plant consisting of an air compressor driven by a 2½-h.p. petrol motor mounted with an air receiver on a wheeled truck, is illustrated in Fig. 5. The overall dimensions of this outfit are 6 ft. by 2 ft. 7 in. by 4 ft. high, and the gross weight is 9 cwt. 3 qrs. The plant will supply enough air to operate two sprayers. In permanent installations the spraying is done under hoods, which are efficiently ventilated and carry away all fumes.

The Aerograph plant is being used amongst other purposes for doping observation balloons and aeroplane wings. It is also used for varnishing shells inside and out, and for painting mines, bombs, hand grenades and munition boxes. It is said to give a more even coating of paint or varnish than it is possible to obtain in brush-work, and it does this in one-fifth to one-third the time, and with a substantial saving of paint. One manufacturer who uses the sprayer for applying the enamel to bicycles puts the saving of enamel at 60 per cent., as compared with dipping. The makers state that the loss of paint carried away as spray with the ventilation currents is insignificant if the spray is properly adjusted to the work in hand.

Preston Time Tables and Port Information, 1918.—There has just been issued by the Corporation of Preston, of which Mr. Alfred Howarth is the Town Clerk, a little brochure, giving much useful information, with illustrations, maps and charts of the port of Preston, with its channel from the Irish Sea, and, along with these, information as to the available berthage, warehouses, &c., including a tide table, all of which will be interesting to those utilising the port.

British Chamber of Commerce at Harbin.—H.M. Consul at Harbin writes calling attention to the existence of the British Chamber of Commerce at that place. The Chamber, which was formed last May, has for its objects the promotion and protection of British trade interests by ensuring the co-operation of British trade interests in Northern Manchuria. The hon. secretary of the chamber is Mr. A. E. Smith, who may be addressed at the British Chamber of Commerce, Harbin.

"The British Engineering Index and Buyers' Manual."—We have received a copy of this manual for the present year. It is compiled by Mr. F. J. Turquand, F.R.S.A., A.M.I.E.E., M.I.M.E., and other specialists, and is published at the price of 10*s.* 6*d.* net by Messrs. E. T. Heron and Co., Limited, 9 and 11, Tottenham-street, Tottenham Court-road, W. 1. It is divided into two main sections, a directory of firms, with postal address, telephone number and telegraphic address, and an index to articles manufactured, the articles being products used in the engineering and allied trades. The articles covered are most numerous, and reference to their manufacturers is quite easy. In the active competition which is sure to obtain at a not distant date, this manual is sure to prove a most valuable guide.

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ADVERTISEMENT RATES.

The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. The pages are 12 in. deep and 9 in. wide, divisible into four columns of 2¼ in. in width. Serial advertisements will be inserted with all practicable regularity, but absolute regularity cannot be guaranteed.

Advertisements intended for insertion in the current week's issue must be delivered not later than 5 p.m. on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received not later than 1 p.m. on Tuesday in each week.

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With Four One-Page Plates of TRACTION ON BAD ROADS OR LAND.

NOTICES OF MEETINGS.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, February 15, at 6 p.m., at the Institution of Civil Engineers, Great George Street, Westminster. The Annual Report of the Council will be presented. Papers to be discussed:—"Traction on Bad Roads or Land," by Mr. L. A. Legros, Member, of London, and "Utility of Motor Tractors for Tillage Purposes," by Mr. Arthur Amos, of Cambridge.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Monday, February 18, at 8 p.m. Meeting in Glasgow. Mr. L. A. Legros, Member, will present his paper on "Traction on Bad Roads or Land," in the form of a lecture, illustrated by lantern slides, in the Societies' Room, Royal Technical College Buildings, Glasgow. Chairman, Dr. Barr, Member of Council.

THE ROYAL SOCIETY OF ARTS.—Monday, February 18, at 4.30 p.m. Cantor Lecture.—"The Effect of the War on the Economic Condition of the United Kingdom," by Mr. Edgar Crammond, F.S.S., Secretary of the Liverpool Stock Exchange. Lecture I—"The Economic Condition of the United Kingdom before the War." Wednesday, February 20, at 4.30 p.m. Ordinary meeting.—"Picturesque Architecture," by Mr. Maurice B. Adams, F.R.I.B.A. Sir Aston Webb, K.C.V.O., C.B., R.A., will preside.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, February 19, at 5.30 p.m. Paper to be further discussed:—"The West Quay of Madras Harbour," by the Hon. Sir Francis Joseph Edward Spring, K.C.I.E., M.A.I., M.Inst.C.E., and "Mr. Hugh Henry Gordon Mitchell, M.Inst.C.E. Paper to be read, time permitting:—"Modern Developments in Gasworks Construction and Practice," by Mr. Alwyne Meade, Assoc.M.Inst.C.E.

THE LIVERPOOL ENGINEERING SOCIETY.—Wednesday, February 20, at 8 p.m., at the Royal Institution, Colquitt Street, when a paper will be read by Professor W. H. Watkinson, M.Eng., M.Inst.C.E., M.I.Mech.E., M.I.E.E., entitled "Our Fuel Resources and Possible Improvement in their Utilisation."

THE INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.—Wednesday, February 20, at 7 p.m., at the University, Edmund Street. Dr. C. C. Garrard will read his paper, entitled "Switch Gear Standardisation."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, February 21, at 6 p.m., at the Institution of Civil Engineers, Great George Street, Westminster, S.W. "Switch Gear Standardisation," by Dr. C. C. Garrard, Member.

THE ROYAL INSTITUTION OF GREAT BRITAIN.—Friday, February 22, at 5.30 p.m. A discourse will be delivered by Mr. Arthur Clutton-Brock, M.A. The subject is "The Importance of Art." Afternoon lectures next week at 3 p.m. Tuesday, February 19. Professor Arthur Keith, M.D., F.R.S., Fullerian Professor of Physiology, Royal Institution, on "The Problems of British Anthropology" (Lecture III). Thursday, February 21. Mr. Edmund Gosse, C.B., LL.D., on "Three French Moralists and their Influence on the War—La Bruyere" (Lecture II). Saturday, February 23. Professor Sir J. J. Thomson, O.M., Pres.R.S., Professor of Natural Philosophy, Royal Institution, on "Problems in Atomic Structure" (Lecture II).

NOTICE.

Owing to the recent Government restrictions, and to the enormous increase in the price of paper occasioned thereby, the Proprietors of "ENGINEERING" are compelled to advance the price of this Journal from 6d. to 8d. per copy. This increase dated from and included the issue of Friday, March 16, 1917. The change will not apply to unexpired subscriptions.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions now imposed by the Government on the importation of paper, and of the consequent shortage of supplies, readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk. Owing to the scarcity of paper it will be impossible in future fully to provide for a chance demand for this Journal.

ENGINEERING.

FRIDAY, FEBRUARY 15, 1918.

BANK AMALGAMATIONS AND TRADE.

THE outstanding feature of the end of the financial year has been the amalgamations amongst the most important joint stock banks, and apprehension has been aroused in commercial circles lest the progress of this policy should lead to further limitation of financial facilities for trade. This anxiety has become so widespread and acute that the Government has been compelled to promise to set up a committee to consider the desirability of official interference with banking amalgamations in this country if it should be found that there is a reason to believe that these amalgamations tend to lessen in any way the free and full flow of credit which is so necessary to the encouragement and stimulation to trade even in normal times, and which will be immensely more important after the war.

The constitution of this committee is a matter of the greatest importance, and it is essential that it should be thoroughly representative. Should it be confined only to the largest bankers and merchants it is feared that it will report in favour of the fusion of interests in order that the great financial problems which will arise after the war may be better dealt with although it is an open question whether these fusions will be for the benefit of the trade of the country. It is very obvious that the immediate period after the war will provide many varied and great financial problems, but from the point of view of the manufacturer undoubtedly the most important and pressing will be that of financing the enormous trade necessarily resulting from the immediate reconstruction works which will be imperatively required. This is apart from the increase of trade required to provide the wherewithall to pay the interest and furnish the sinking funds on the loans floated during the war. It is from this point of view that the question should be approached.

It is common knowledge that in the past traders generally have greatly complained that there seemed to be a growing difficulty in obtaining sufficient aid and support from the banks to enable them to carry on their business, and to meet their foreign competitors on more equal terms, and this has been the subject of comment in these columns on several previous occasions. Undoubtedly it is of immense importance—indeed, it is vitally necessary—that the flow of finance should be unimpeded and accelerated. The view that there was some obstruction in the administration of the existing system of banking was upheld by the report of Lord Faringdon's Commission. This resulted in the establishment of the British Trade Corporation, which is still, of course, in its infancy, but which will, if allowed to develop on the lines laid down, do much to remedy the defects shown to be existing, particularly with regard to foreign trade. There is still, however, a general concensus of opinion among business men that in the interests of internal trade it is highly important that some reform should be made in the administration of our present banking system to allow of a more elastic system of facilities for financing trade. This is of the greatest importance both to those who are convinced that the end of the war will see a boom in trade and a long period of unbroken prosperity, and to those who can only see a long continuance of the war, and a crushing burden of debt.

The great point to be decided is whether these bank amalgamations will give us a more efficient service, or whether they will perpetuate and even intensify the present difficulties. It must be remembered that the provision of increased credit facilities must lead to an increased production and, consequently to increased consumption, which cycle will act and react to the great advantage of the community at large. This must be the end and aim of all our efforts if we are in any way to mitigate the heavy load we shall have to bear after the war, which will in the absence of special remedial measures prevent or at least postpone for a very long period the return of our commerce to anything approaching its pre-war standing.

One of the most apparent benefits of the amalgamations, and, indeed, the principal reason for them, is the strength and security of the resulting institution, and the accession of power which these two attributes bring. It is obvious of course that a corporation possessing a capital of, say, 10,000,000*l.*, with a reserve fund of the same magnitude and able to rely on deposits about twenty times as great, must be enormously strong, and inherently powerful. It would be able to undertake the largest propositions which might be placed before it, and by reason of its exceeding strength to insist on the most stringent regulations to ensure the successful completion of the various schemes in which it joined. It would also be able advantageously to entertain and carry through semi-national undertakings to the mutual benefit of itself and the community. Further, by reason of its vast resources it would ordinarily be secure against disastrous failures, for the largest responsibilities it undertook would bear but a small proportion to its resources, and as it would command confidence it would be enabled to operate on the finest terms. In most cases the amalgamations extend the combined operations over a much larger geographical district, and thus provide increased facilities in new districts, and it is apparent that they can generally be much more economically administered. Where these two advantages result in better terms being offered to customers it is, of course, to the advantage of trade.

The disadvantages are not so palpable, although

as will be shown, they are very real and largely responsible for the present dissatisfaction.

If the history of our present banks is traced, the apprehension now so strongly expressed that these amalgamations are not to the benefit of the country will be found to have arisen from the amalgamations of the private banks with the joint stock banks, and the gradual substitution of an impersonal conduct of banking for a personal system. Under the old system of private banks, the partners were usually resident in the district in which the bank did business, and in course of time they obtained a very good knowledge of the financial requirements of the industries of their district, and of the commercial responsibility of the customers of the bank. As they naturally were always accessible, even to the small man, they were able to judge fairly of every application which came before them, and if they considered it advisable, to render assistance, even though they then took a slightly greater risk than usual. In addition, they were often able materially to assist their customers by their knowledge and advice. But when these gentlemen were replaced by a local manager, who was often ignorant of the locality and who was invested only with very limited powers, such applications received very different treatment. Many a reasonable request was refused outright by the manager because it was felt by him that it was not only hopeless to forward the application for the consideration of the board of directors, but also that, should he send it forward, it would be a reflection on his ability. Another great drawback was the time necessary to obtain a reply to any application, as all of them of any magnitude required to be placed before the directors for their sanction, thus causing considerable delay, which often prevented the closing of a profitable deal. Again, any advances that were made were only granted for a short period, and in consequence of the want of knowledge of the bank's customers which is a concomitant of the system, were often hedged round with impossible conditions very rigidly enforced. It was, also, soon found in practice that it did not pay to give much attention to a multitudinous selection of small requirements, as it was so much more profitable and economical to concentrate on large deals. Although these drawbacks were too intangible to be openly dealt with, they have been responsible to a very large extent for the dissatisfaction and apprehension now so widely prevalent, and they are bound to grow in increasing proportion as the amalgamations proceed. This will be specially the case after the war when it will be most important that everyone who can add to the wealth of the country by producing manufactures for export should be encouraged to the fullest extent. The manufacturer will find it more than ever difficult to obtain the necessary financial assistance, and may even be forced to become an employee, instead of an employer, because of the difficulties placed in his way of obtaining the necessary financial facilities. It is, therefore, no wonder that the far-seeing trader is not in favour of these amalgamations. Another great drawback to the huge concentration of capital and resources which accrues through these amalgamations is that too much attention is given to foreign trade to the detriment of home trade. No one is so foolish as to pretend that a good foreign trade is not to be encouraged and supported, but it is also wise to encourage and stimulate home trade so that the wealth of the country may increase and that the populace may be assured of constant work at good wages. It is to be remembered, too, that these institutions are directed by a body of gentlemen, who are often selected for these lucrative positions for many other reasons than that of aptitude, and who often remain upon the board long after they have passed the age of usefulness, or who may be directors or partners of other exacting businesses. Consequently the administration of the bank tends more and more to be at the mercy of the permanent official, and the necessary stimulus to enterprise and efficiency is very often entirely absent from its policy.

Altogether looking at these amalgamations from the point of view of the manufacturer and trader it would seem to be necessary to place a severe restriction on future projects, firstly because such unwieldly aggregations are detrimental to the internal trade of the country, and also that by reason of their magnitude they will be so powerful that the intervention of Parliament will be necessary for their control. It is, in fact, a very open question whether the admirable system of deposit banking which we at present possess, and which is the envy of other countries because it can only exist in a wealthy community like ourselves, has not developed to the highest degree that is possible to it, and whether in view of the special exigencies of the times, it will not be necessary to evolve an additional system of commercial banking which will allow of more freedom and encouragement to the trader, combined with reasonable security and resources.

THE DISCHARGE OF SEWAGE EFFLUENTS AND STORM-WATER.

The various reports on research work which have from time to time been published by the Metropolitan Water Board, should have done much to allay any fears which may have previously existed as to the possibility of conveying disease by water drawn from polluted rivers. Modern methods of purification have proved so effectual in the removal, devitalisation and destruction of micro-organisms of intestinal derivation, that while it is recognised that every care should be taken to protect such sources of supply from specific contamination by infected excreta, there is little reason for feelings of anxiety or suspicion, provided always that measures are taken carefully to guard the purified water during the interval between the completion of the purification process and delivery to the consumer. Speaking in a bacteriological sense, it has been shown to be possible by storage and filtration to improve a river water 1,000 times, while by treatment by what is known as "The Excess Lime Process" it may be improved to the extent of from 10,000 to 100,000 times; in fact, one of the more recently published reports goes so far as to say "that river water, no matter how impure it may be, can be brought into a condition of absolute safety bacteriologically, and of great relative purity chemically by means of lime."

But apart from the question of danger, it is necessary to consider that of nuisance consequent on discharges into rivers and streams, whether utilised as sources of water supply or not. And in view of the suggestions put forward by the Commissioners appointed to report on methods of Treating and Disposing of Sewage (1898), it would seem possible to feel equally confident on this point, in so far as discharges from sewage works are concerned.

It will be remembered that the Commissioners when framing these suggestions put aside the test for ammoniacal nitrogen (which they regarded as the most delicate chemical index of recent sewage contamination) on the ground that it could not be relied upon to indicate the character of pollution, as shown by the effect which a given sewage liquid would be likely to have upon a stream, and recommended that expressed by the absorption of dissolved oxygen during a period of five days.

In suggesting this test, the Commissioners pointed out that "the nuisance-producing power of a normal sewage or effluent (apart from the questions of temperature), is broadly proportional to its power of deoxygenating the water of a stream, and tests based upon the rate and degree of absorption of oxygen are the most trustworthy tests for determining whether nuisance is or is not likely to be caused by the discharge of such liquids."

The conditions proposed by the Commissioners embrace a general and also special standards; the latter to be higher or lower than the general standard as local circumstances require or permit; such variations to be regulated by the possibility of degrees of dilution with volumes of relatively clean river water. As is well known, it was considered that the oxygen absorbed test should be applicable up to a minimum dilution of 150 volumes of river water, and that a test for suspended solids should vary from three parts per 100,000 in the general standard, to six parts for a minimum dilution of 150 volumes, and fifteen parts for a minimum of 300 volumes, while in the case of dilutions with over 500 volumes of river water, all tests should be dispensed with, and crude sewage be allowed to be discharged, subject to the provision of such screens or detritus pits as might appear necessary.

In suggesting these standards and tests, the Commissioners considered among other possibilities as likely to arise from the discharge of unpurified or imperfectly purified sewage into rivers or streams: (*a*) The deposition of suspended matter, and its accumulation in the river bed, and behind weirs, and (*b*) the putrefaction of organic matter in the river to such an extent as to cause nuisance. And when proposing restrictions bearing upon the discharge of suspended solids it was recognised, that "while dilution with a sufficient quantity of clean water is capable of dealing satisfactorily with the dissolved impurities of sewage liquors, the purification by this means of the suspended organic matters discharged into a stream, is not as a rule rapid enough to forestall the cumulative effects of their deposition on the river bed. Nuisance is likely to arise from the accumulation of putrefying mud, and the deoxygenation of the water above it; unless the bed is cleaned intermittently by the scouring action of floods, or continuously by the natural velocity of the current; and even in such cases the solids are not as a rule dispersed, they are merely transferred to some spot which is more favourable to their accumulation."

The facts that suspended solids from biological beds and filters are in themselves putrescible, and that deposits having undergone anaerobic fermentation (when disturbed), rapidly exhaust the dissolved oxygen of river water, when taken into consideration with the small volume which, generally speaking, characterises our rivers and streams, show sufficiently the importance of restrictions bearing upon the discharge of suspended matter.

In view of the standard controlling the discharge of sewage effluents, with the compulsory and complete treatment of three times the volume of average dry-weather flow, together with the partial treatment of three further volumes by passage through storm-water tanks, there is little probability of nuisance arising in rivers consequent on the discharge of suspended solids from sewage purification works, as the bulk of the solids brought down during times of storm can, by the means suggested, be rapidly removed.

But while the number of days upon which the total quantity of sewage and storm-water arriving at the outfall works will equal six times the volume of the normal flow, may be small, it is obviously impossible to convey that quantity to a treatment area at the rate at which it collects in the sewers, apart from great expense, and also apart from the risk of damage from flooding. The flow in sewers during heavy rain being generally many times in excess of the dry-weather flow, the provision of storm-water overflows cannot be avoided, although their frequent association with discharges of undesirable matter makes it difficult to regard them otherwise than as a necessary evil.

The Commissioners when considering the question of overflows on branch sewers, while recognising the injury frequently done to rivers owing to their operation, realised the impracticability of altogether dispensing with them, but recommended that they should be used sparingly; that they should usually be set so as not to come into use until the flow in the sewer is several times the maximum normal dry-weather flow; and that the general principle of avoiding the release of such an amount of unpurified sewage as would be likely to cause nuisance, should be carefully kept in view in regard to their design and adjustment. On the other hand it may be argued, that the placing of storm-water outlets at a number of points on a river, lessens the possibility of nuisance which is likely to arise in connection with a more concentrated discharge, and moreover, that as heavy storms are frequently very local in character, the linking-up of sewers conveying storm-water to a river, would tend to minimise floodings.

But ideal conditions which aim at the prevention of floodings under all but extraordinary storms, and at avoiding the discharge of undesirable matter into rivers or streams, are recognised as very difficult of attainment. The engineer will naturally

endeavour to prevent the diversion of storm-sewage in connection with slight falls of rain, or when possible, previous to the main sewers doing their utmost; but in attempting to arrive at conclusions as to the quantity of surface water likely to reach the sewers on a given rainfall, he not only as a rule has to work on very imperfect data, but is faced with difficulties arising from constantly varying conditions.

Various formulæ are in use which are of considerable value in determining probable volumes to be dealt with, but quite apart from such questions as time of assembly and continuity of flow as affected by character of surface, the general fall of area drained, or the gradient of sewers, the effect of a given rainfall will vary according to the nearness or distance in time of previous storms, and upon whether or not such storms are travelling along the line of the main sewers.

Difficulties with regard to attempts to guard against impurity of discharge are still greater. Dilution with so many volumes of storm-water cannot carry with it ideas of any value, even in the same town, owing to varying periods of assembly at different points, while speaking more generally, variation in the strength of sewage arising from trade discharges, the leakage into sewers of subsoil water, or the presence of deposit, render it still more meaningless, and it becomes almost impossible to judge of the quality of discharges except at the outlet, as shown by the effect upon the banks and bed of the river. The first flush of storm-water consisting of street washings is, in busy districts, known to be very impure, being frequently worse in every respect than sewage, while the length of time during which such impurity is perceptible it often considerable.

Various measures have from time to time been employed for preventing undesirable matter from reaching watercourses, and these have proved more or less successful; but as the period of maximum impurity of discharge generally corresponds with the time of the maximum intensity of the storm, which very frequently occurs some time after its commencement, it is difficult to prevent the more impure storm-water from reaching the watercourse, or that which is less impure, and which reaches the sewers later, from passing to the treatment area.

One of the most effectual means tending to the prevention of nuisance, consists in the adoption of a combined system for busy districts, and a separate system for those where traffic is small.

Greater purity of discharge may also be ensured (where the separate system is in operation), by providing leaping weirs on the surface-water sewers, whereby the first flush of storm water is diverted to the sewage sewers; or by constructing settling tanks at the various outlets. This latter method is however, expensive both on account of first cost, and that involved in the labour of cleansing, and the removal of deposit at widely distributed points. When the stream receiving storm-water discharges is very small, possibility of nuisance may be minimised by the storage of flood water during rainy seasons, and its release either gradually, to augment the volume of the stream, or periodically for flushing purposes.

In conclusion, it may not be out of place again briefly to refer to the inadequacy of available data, in regard to the quality and quantity of storm-water which has to be dealt with. There is probably little exaggeration in the statement that in the majority of towns very little is known either concerning the proportion of rainfall which reaches the sewers; the periods during which under varying conditions discharges of storm-water are characterised by marked impurity; or the degree of such impurity; although it would appear possible without great trouble or expense, to obtain such very necessary information. The valuable report written by the late Mr. Baldwin Lathom, and printed in the evidence given before the last Royal Commission on Sewage Disposal, gives particulars as to the relative amounts of rainfall reaching the sewers in various towns; and the tabulation of such, and similar information, and its classification with regard to conditions peculiar to different localities, should prove a useful guide in approximately estimating volume. The quality of discharges can be obtained either roughly or with exactitude from records of rates of assembly, or by analyses taken at the various points of relief, and if the height of weirs were governed by such information rather than by degrees of dilution, much objectionable matter would be kept back, and greater equality in the relative impurity of discharges would be secured.

HYDROGEN REACTIONS AND CATALYSTS.

To the young chemist hydrogen is in the first instance the lightest and, so to say, the most elementary of all the elements, and also the general great reducing agent which, though sluggish at ordinary temperature, becomes exceedingly active at high temperatures and reduces most metals, because it combines with the oxygen of metallic compounds. The physicist makes use of the minimal density of the hydrogen when he wants to prepare his "vacuum tubes"; technically that property is utilised in filling balloons, and at present hydrides processes of hydrogen generation find application—*e.g.*, from hydrides, compounds between metals and hydrogen—which the high expense would make impossible in peace times. In the dye industry and in organic chemistry generally the reducing qualities of hydrogen play a very important part. It is not only that hydrogen acts to remove oxygen by combining with it. In many cases addition products are to be formed, and more hydrogen to be introduced into the molecule. The hardening of oils is one of the most important of these reactions. Both the liquid oils, difficult to purify, often of disagreeable smell and taste and hence of low value, and the solid fats, more easily purified and of higher value, are glycerides, that is, compounds of glycerol (or glycerin) with organic acids. In the oils it is oleic acid or some other "unsaturated" acid; the saturated acids of the fats contain two more molecules of hydrogen. To introduce those molecules of hydrogen and to accelerate the reaction for technical purposes, a catalytic agent is needed.

Two of the papers brought before the Faraday Society in December last dealt with the catalytic acceleration of hydrogen reactions. In the first paper Dr. E. B. Maxted, of Walsall, described experiments on "The Influence of Carbon Monoxide on the Velocity of the Catalytic Hydrogenation of Olive Oil." The hydrogen to be used in synthetic reactions should be pure and free particularly of carbon monoxide as this acts as a poison to the catalyst which, in the hardening of oils, is generally finely-divided nickel. That condition of purity precludes or limits the use of the hydrogen from water gas. Dr. Maxted finds that the first traces of CO (0.25 per cent. in his experiments) have relatively the greatest effect on retarding the hydrogenation. He passed mixtures of pure hydrogen with up to 2 per cent. of CO into a vessel containing pure olive oil and continued his experiment for one hour, at the end of which about three-quarters of the oil would be saturated; the dilution of the hydrogen with CO would in itself have an influence which he determined by calculation. The results were hardly new, and his "closed-pocket" method was criticised by Dr. H. C. Greenwood, who said he would have preferred a streaming method and would determine the influence of dilution with the aid of nitrogen or some other inert gas. Dr. R. Lessing further pointed out that Dr. Maxted did not state how he prepared his catalyst—a matter of primary importance—and that the impurities would accumulate in the closed vessel and would accentuate the poisoning effect. Owing to the method employed, it looked moreover as if the hydrogenation would altogether be stopped by a few additional per cent. of CO. Using nickel carbonyl as catalyst in his own process Dr. Lessing said he could work with hydrogen containing even 50 per cent. of CO, which he passed at 200 deg. C. in a continuous stream over the nickel so that the carbonyl was constantly being formed and decomposed again during the reaction, the high efficiency of the process being probably due to the enormous surface of the reduced nickel atoms which were the real catalyst; a mirror deposit of nickel did not act catalytically, he had observed.

The second paper by Dr. E. B. Ludlam on "The Effect of Hydrogen Chloride on the Nitrogen–Hydrogen Equilibrium" concerned the synthetic ammonia process of Haber. It will be remembered that it took Haber and his collaborators—among whom Dr. Greenwood was for a time—years to work out the equilibrium conditions existing between nitrogen, hydrogen and ammonia at temperatures between 500 deg. and 1,000 deg. C. and at pressures of several hundred atmospheres, although it had long been known that nitrogen and hydrogen would combine to a certain, very small, extent. The success of the process depends upon the high pressure, the purity of the materials and the efficacy of the catalysts of which a large variety were tried by Haber. At low temperatures the reaction is exceedingly slow; the rate is accelerated by raising the temperature and pressure, but the equilibrium concentration of the ammonia is then very small, and unless the ammonia can be removed from the active zone, it is decomposed again, and the final ammonia yield is low. Now Deville had observed that ammonia was far more stable in the presence of anhydrous hydrochloric acid than when alone. It occurred to Dr. Ludlam to test this statement which, if confirmed, promised to furnish an efficient Haber-Deville process, dispensing with the necessity of high pressures. Ammonia and hydrochloric acid readily combine to ammonium chloride (sal ammoniac), but this salt is known to dissociate on heating again. Strangely enough most of these dissociation experiments do not appear to have been pushed above 300 deg. C., and Deville's statement, that the chloride was only dissociated to the amount of 14 per cent. at 920 deg. C., had never been properly revised. In fact, as Professor Alexander Smith (American Chemical Society) pointed out in 1915, very little is known about the dissociation of saturated vapours in general, although those data would have the greatest chemical significance; Smith found that the dissociation of ammonium chloride began to decrease above 300 deg., did not exceed 67 per cent. at 330 deg., and was probably never complete.

Ludlam first tested Deville's statement in various ways. Passing ammonium chloride vapour forward and backward through quartz tubes charged with pieces of broken quartz, he found that there was little decomposition of the chloride below 900 deg., but considerable decomposition at about 1,000 deg. Thus Deville was only partly confirmed. Ludlam then attempted to stabilise the ammonia formation by adding anhydrous gaseous hydrogen chloride to the hydrogen and nitrogen. The gasses were passed through a tube, an axial wire or rod in which was electrically heated. With platinum wires, and with carbon rods, impregnated or not with alkali chlorides or coated with copper, no increase of the ammonia yield was obtained. When a wire spiral of iron—one of Haber's best catalysts—was used, wrapped round a quartz rod, white fumes were observed, and the dull red wire turned bright red; but the fumes were due to ferrous chloride, and not to ammonia. After further unsuccessful experiments the equilibrium was approached from the other side, that is, the decomposition of ammonium chloride in the presence of nitrogen, hydrogen and hydrogen chloride was studied. This was done in a quartz bulb which was heated in a tubular electric furnace. When heated alone for five hours to 950 deg., without a catalyst, the ammonium chloride remained practically undecomposed, and Deville was thus supported; but when the temperature was raised to 1,100 deg. a decomposition of 10 per cent. of the salt was observed. When gold (melting-point 1,063 deg.) or silver (melting-point 961 deg.) were added as catalysts, and the temperature was kept near these melting points for several hours, the decomposition reached 32 per cent.; a silver mirror, which turned grey during the heating, caused hardly any decomposition. With catalysts of copper and especially of iron (at 750 deg.) the decomposition was nearly complete, but the resulting gases were hydrogen and nitrogen, and contained hardly any ammonia. The iron experiments were modified and performed at lower temperatures (500 deg.), asbestos being impregnated with ferrous chloride which was then reduced to metallic iron to act as catalyst in a mixture of nitrogen and dry

hydrogen chloride. More ammonia was obtained in these experiments; but the formation of ferrous chloride was a disturbing factor, and the doubtfully promising research was discontinued. Dr. Ludlam is not in a position to resume the experiments, and it does not look as if the use of hydrogen chloride would lead to a process that might rival the Haber process. Yet further investigations and in general further determination of accepted facts and "constants" appear desirable.

STRIKES AND SOCIALISM IN GERMANY.

There has been much speculation as to the significance of the recent strikes in Germany. How far they were industrial and how far political is not clear. It is certain, however, that there must have been some potent motive, either on the part of the men or of their leaders. to cause them to strike under conditions which entail the risk of them being put under martial law administered with an iron hand. Probably many causes co-operated towards the result, and prominent among them was the desire of the Socialists to aim a blow at capital. The times are propitious for such a course, since the war has led to many amalgamations, partially spontaneous, and partly forced upon capitalists by the Government. Nationalisation of an industry is a smaller step when the component parts of it have already been gathered up into a great combine, or are controlled by a selling kartel, than when they are in the hands of scores of private firms. Further, arguments based on the greater energy and initiative of individuals, as compared with Government departments, lose much of their point when control is already lodged in large boards of directors, or in the management of great trusts. Events appear to show that the German Government is by no means adverse to try big experiments in mining, manufacture and trading for the sake of obtaining increased income in the future to meet the war debt, and the Socialists would willingly supply them with arguments by demonstrating the incapacity of the combines to control labour. Of course, nationalised industries administered by a military autocracy do not offer much advantage to the proletariat, but promises have been made of a more liberal franchise in Prussia, and the labour leaders hope that they may yet extort greater privileges in the confusion to be expected when the conditions of peace demonstrate the damage wrought by the war to Germany's export trade.

Some light is thrown on the present condition of affairs by a recent publication in which four Social Democratic leaders set forth the views of the workmen on one of the most important industrial problems of the near future, that of monopoly. No doubt seems to exist as to the further development in Germany of more or less monopolising syndicates in one form or the other after the war, both from industrial and financial causes. But on the other hand widely divergent views are taken as to the direction in which this evolution should be led or allowed to go on. Is the State to take up, or the large industrial groups to proceed with, this matter?

Without going into too many details it may suffice to mention that in the artic'es in question a short survey is first given of the development of the present system of kartels, and it is maintained that all kartels, and syndicates, from the loosest price convention to the fullblown trust, only have had one aim: the increase of profits. All other considerations in this connection are unimportant. In addition, it is maintained that, with insignificant exceptions, the kartels have been formed, not in times of industrial depression or trouble but on the contrary, during periods of high degrees of employment in order to keep up, if possible, and as long as possible, the high prices and the favourable conditions for sale. This author does not deny that labour, too, has derived advantages from the formation of kartels, but they are only of small moment compared with those of the employers. He maintains, that in the same way as the adoption of machines in industry became a necessity, an indispensable link in the evolution, so the kartel-formation is another necessary phase, to prepare and level the road for a subsequent and higher stage: the socialistic organisation of the industry. The question is no longer whether State monopolies are desirable, but which commercial and industrial branches will best lend themselves, or are best suited, for Imperial undertakings, and how, under the present financial position of the State, can the monopolising be carried through in the best manner for the benefit of the masses of the German nation.

Another writer underlines as his view, that the future Imperial monopolies in the first instance must be made to comprise the industrial branches, within which private capitalistic, industrial and financial centralisation already has been advanced or pushed to what may be termed private monopolies. Mining industries, more especially coal-mining, should lend themselves particularly well to a State monopoly. He admits the merits of the enterprising spirit of the large captains within the German industry in the development of the mining industry, but he is of opinion, that the period, when perhaps private development was the most useful, is past. Separate or individual development can hardly be said to exist any more. He quotes a statement by the former Minister of State, Herr Möller: "As soon as the combines develop into monopolies, the great majority of the German people will be roused to a very serious extent, and if a monopoly is no longer to be avoided, an overwhelming majority of the nation will prefer a State monopoly to a private monopoly."

Another writer, and it must be remembered that these men voice the opinions held by German Social-Democratic labour, a factor which all sides now admit, has to be seriously reckoned with, dwells upon the reasons which formerly made the Social-Democratic party go against State monopolies and their present altered attitude to the question. He expresses much the same trend of thought, as Jansson put forward in the concluding chapter of his book, in the following words: "That however, does not exclude, that the power on the side of the employers at times can develop more quickly, and such more rapid growth results from the industrial conditions the war has brought about. The legislative organisation of important branches within the national industry accelerates the growth of power of capital as against labour. As labour, however, must reckon upon a similar development of the organisations of capital also after the war, it is more expedient from the standpoint of labour to further the endeavours towards a legislative regulation of affairs in the interest of the empire, provided that the legislative measures show proper regard to the interests of labour."

It is freely admitted in Germany that whatever views one may hold, it cannot be overlooked that the opinions expressed above are those of an influential political party, which has greatly improved its position during the war, and might possibly be welcomed as an ally by the Government if financial reasons obliged the latter to strain the loyalty of the manufacturing interests severely.

NOTES.

Female Labour in German Foundries.

In Germany as in this country female labour is being utilised in many industries hitherto considered unsuitable for it, and among these in iron-founding. The managers were met at the outset with the problem of instructing the new recruits in their work. The old plan of putting a woman to work with a skilled man, or under a foreman, was naturally tried first, but it was not found to be satisfactory. Apart from any possible disinclination of the man to pass on the fruits of years of experience to the newcomer, was the fact that he might have no skill in teaching. He had entered the foundry young and had imbibed the elements of his knowledge quite unconsciously so that he did not realise where it was necessary to begin. His very terms and expressions were an unknown language to his pupil, and he failed to make himself intelligible however zealous he might be. After many failures had been experienced a new method was tried. The more intelligent and successful of the early recruits were appointed as teachers, and as they understood the difficulties which they had encountered, they were able to explain, by word and demonstration, to the later comers what it was that was expected of them and how it was to be attained. In some cases women of higher social standing and intelligence were enlisted and, after being carefully trained, were deputed to instruct the others, and this plan was followed by greatly improved results. The moulding of light articles should be easily done by women on account of their delicacy of touch and general deftness of manipulation, but heavy moulding is another matter, and German experience shows that women cannot equal the output of men, even when they adopt men's attire, and good arrangements are made for their comfort. Still women can be employed at almost all descriptions of work, except the heaviest and at some jobs in connexion with the cupolas and pouring the metal. In the production of green cores on machines, women soon surpass in output the younger male hands, from 17 years to 18 years, formerly employed at this work. It has been found very advantageous to put women into gangs, their anxiety to do equally well or better than the others increases their output, the task of learning becomes simplified, and it is easier to single out and remove those less efficient. In the foundries women have also been employed for fettling at the emery wheel, and for sand blasting, but it is not always easy to find women physically suitable for these purposes. As regards the wages of the female hands the German practice in engineering or mechanical works is to fix the female piece tariff about one-third lower than the male tariff. This has not been found satisfactory in the foundry, where women have the same tariff as the men. Women would probably not accept work in foundries if it were not better paid than on machine tools.

Magnetisation and Röntgen-Ray Examination.

The particles of iron and other magnetic substances are supposed themselves to be small magnets which are pointing in all possible directions, as long as the iron is not magnetised, but which arrange themselves in parallel lines under the influence of external magnetic force. With the aid of a group of small magnetic needles, which all turn in the same direction when a strong magnet is approached, the magnetisation process can very prettily be illustrated. But this well-known experiment must be regarded merely as an illustration, and not as a demonstration of the actual phenomena. The difficulty is to understand the nature of the ultimate magnetic particles, which are to be turned by magnetic forces, and X-ray examination, which has cleared up some of the difficulties of crystallisation phenomena, so far rather appears to complicate the magnetisation problem. Most of these researches have been conducted in America. A. H. Forman (*Physical Review*, since 1914) studied the effect of magnetisation on the opacity of iron to X-rays. He observed that iron seemed less transparent to penetrating X-rays when magnetised in a direction parallel to the path of the rays than when magnetised at right angles to that direction or when not magnetised. The difference observed was very small, 5 parts in 3,000, at the best; but he considered that the ultimate magnetic particles were the molecules of iron, and that the plane of maximum absorption of the iron molecule was parallel to that of the electronic orbits which make up the elementary magnet. But A. H. Compton and O. Rognley maintain, that any such orientation of the molecules could only be extremely small. According to Bohr's theory of the atom the magnetic properties would be due to the electrons all lying in the same plane which revolve about the atomic centre. Compton does not accept that. In X-ray examination after Bragg, he points out, the intensity of the reflected spectrum line depends upon the distance of the electrons from the middle plane of the atomic layers in the diffracting crystal. When the crystal of iron is not magnetised, the atoms will have their electrons arranged in all possible planes. When the crystal is magnetised at right angles to the reflecting crystal face under examination, the orbits, being at right angles to the magnetic axes of their atoms, would all be driven into the

middle plane of the layer of atoms, and this shifting of the atoms would produce an increase in the intensity of the reflected beam. With magnetisation parallel to the face, the beam intensity should decrease; but Compton and Rognley did not observe any intensity changes at all. They do not believe in an electron as a point-charge; they deduce from other experiments as well (see Journal of the Washington Academy of Sciences, January 4, 1918), that the different parts of the charge of the electron can possess certain motions independent of one another, and that the distribution of the electrons in the atom is isotropic, *i.e.*, not confined to one plane; the ultimate magnetic particle might then be the electrons themselves, or the atomic nucleus. Somewhat similarly, A. L. Parson had suggested (Smithsonian Institute, Collections, November, 1915) that the atom is made up of a positive nucleus and of magnetons, the latter being ring-shaped negative charges (or electrons). The possibility of a simple explanation of magnetisation seems to be very remote.

Co-Partnership.

All thoughtful minds are wondering what form the relations of labour and capital will take after the war. Peace with our enemies will not restore us to prosperity unless we also have peace at home, for it is clear that the burden of increased taxation can only be met by enlarged output and reduced manufacturing costs. These results demand for their attainment the hearty co-operation of labour and capital, and the most urgent question of the day is the means for obtaining this object. In all departments of life disputes mainly arise from want of knowledge or of imagination. If we could each put himself in the position of his opponent, and see the point at issue from the other side there would very seldom be any difficulty in arriving at a working compromise. Unless something of this kind can be done in industrial matters there is not much hope of our attaining the peaceful conclusion that is so urgently needed. Various proposals have been put forward, and only last Wednesday Lord Leverhulme put his views before the Royal Society of Arts. Whatever he says on this subject deserves attention, for he has not only achieved great commercial success, but his relations with his workpeople at Port Sunlight are of a most cordial character. He recommends the institution of co-partnership schemes, saying "co-partnership relations with the employee worker would be an added source of strength to any business to which co-partnership could be applied, and would increase the prosperity and happiness of both the employer capitalist and the employee worker." Under a system of co-partnership the worker would receive each year an allotment of co-partnership certificates in proportion to the amount of his salary or wages, and the length and value of his services. These certificates during the co-partners connection with the firm would be entitled to dividends in proportion to the dividends paid to the ordinary shareholders, and the co-partner would see the number of co-partnership certificates growing each year. He would realise the cause why dividends some years were higher than others, and why some years, from unavoidable causes, dividends might fail to be earned or paid. He would realise the direct connection between profits and all the problems that the management have to solve in a business. This would be a great step towards securing that diffusion of commercial knowledge among the workers which is desirable. But it is difficult to see how it could do much towards securing the higher standard of living that is put in the forefront of the workers' programme, at any rate in the engineering trades. As a correspondent points out in this issue the average capital expenditure in engineering works is 200*l.* per employee, the average return to shareholders 4 per cent. Under these conditions it is certainly most difficult to see where the funds for providing co-partnership certificates are to come from, unless the dividends are to be reduced from 4 per cent. to 2 per cent., and then the certificates would not be worth half their face value. In a business which has a large capital per employee and pays good dividends there would be more ample scope for Lord Leverhulme's plans, particularly if a considerable proportion of the employees were unskilled and therefore paid on a low scale. A moderate reduction of dividends would then enable a fair amount of share certificates to be distributed annually, and these additions to income would be relatively considerable. Generally speaking, these conditions do not obtain in engineering businesses, and we fear that the solution of the difficulties in the industry are not, under present conditions, to be found in co-partnership.

LITERATURE.

With the French Flying Corps. By CARROLL DANA WINSLOW, of the French Flying Corps. Illustrated. London: Constable and Co., Limited. [Price 3*s.* 6*d.* net.]

IN this little book, Mr. Winslow, an American, describes the training and practical education that the French authorities consider necessary for the equipment of the officers of the aviation service, in order to enable them to fulfil the dangerous and arduous duties so eagerly courted by the many volunteers eager to enlist in that arm of the service. Perhaps from prudence, perhaps from modesty, the author is silent or brief on many points to which we should have listened with respect and interest, but enough is said to show the thoroughness of the training, the high standard of efficiency the candidate is required to attain, and the large amount of experience that is considered necessary for a military pilot. The author intimates that his countrymen, unaware of the strenuous conditions imposed by stress of war are insufficiently trained and will have much to learn. In the piping times of peace, a pilot might obtain a licence in six weeks of leisurely work, but in France, under the forced draught of war conditions, the necessary experience cannot be acquired by apt pupils under four to six months. We say "apt" advisedly, for some men, however eager and devoted, cannot learn to fly, "their temperaments prevent it, and try as they will, they cannot improve." The end predicted for such men is sad: "These men will kill themselves sooner or later, if they persist in their efforts to fly."

Moreover, the course is not uniformly progressive. There are graduated steps in the training, the successful passage of any one permitting the partially-trained aviator to perform certain duties, but to advance from one step or class to a higher, the candidate has to start afresh from the lowest step. Mr. Winslow had reached such a stage that he was a fully-accredited pilot permitted to fly a heavy machine, and in this capacity was entrusted with some important duties in the historic and glorious defence of Verdun. But when he wished to undertake the management of a lighter machine, betokening the passage to a higher class, his previous experience counted for very little, and he had to go through the elementary courses and start as a very tyro. This discipline is necessary, because the management of a monoplane or small Nieuport requires greater delicacy in handling than the heavier machines, and the pilots have to acquire a "new sense of touch," of greater nicety than that needed when flying in the larger biplanes. New expedients have to be learnt: new devices for escaping from threatening accidents. The manœuvre that is a source of danger to the beginner, and therefore avoided, becomes a weapon of safety or defence in the hands of the expert pilot. Looping the loop, which at one time was considered a daring and imprudent feat, has become a commonplace, but the "*renversement sur l'aile*" and the dreaded "*vrille*," or tail spin, in which the aeroplane comes down in a whirlpool, "spinning like a match in the waste of a basin," are still the accomplishments of a master. Many aviators are killed while acquiring proficiency in the last-named manœuvre, but the necessary skill has to be attained, for in modern aerial warfare, readiness to perform such feats may offer the only means of escape from the onset of an assailant, or provide the means for making an irresistible attack on a foe.

Mr. Winslow does not harrow our feelings by many tales of disasters or test our credulity by appeals to the marvellous. Only the most venturesome can claim to have had part in a real adventure, and the author would have us believe that his duties were of the ordinary type that falls to the aviation officer that directs artillery fire, or assists in the photographic service. To comparatively few, however, is it given to see the tactics of a great battle raging over a large area develop in their entirety. From his lofty point of vantage, Mr. Winslow could see, however, little more than any other participant, whose vision is limited to his immediate surroundings. The whole Verdun sector was spread out like a relief map—Vaux, Douaumont, Mort-Homme and other places whose names have become as familiar as household words were distinctly recognisable—but he tells us that the actual deadly conflict "looked more like a pan of boiling water, with the steam hanging in a pall over it, than anything else I can think of. Tiny flashes showed where the guns were concealed, but to us the battle was a silent one. The noise of our motor drowned the whistling of the shells and the roar of bombardment."

Photographs taken from aeroplanes showing a typical disposition of French and German trenches are given, and these are instructive, but others showing the results of the fighting at Cumières in May and June, 1916, are on too small a scale to be of much service. If the remarks on the armament carried by aeroplanes had been fuller, the interest would have been increased, but no doubt this cautious reticence is assumed for very good reasons. To insist on the necessity of adequate training and the acquirement of sufficient experience is to render a greater service than would have resulted from the recital of sensational incidents or the introduction of graphic pictures that might tend to make the service more popular among the uninitiated.

Heat-Drop Tables. Calculated by HERBERT MOSS, M.Sc., A.R.C.S., D.I.C. London: Edward Arnold. [Price 5*s.*]

Heat-Drop Tables. High-Pressure Gauge Pressures. Low-Pressure. Absolute Pressures. Calculated by HERBERT MOSS, M.Sc., A.R.C.S., D.I.C. London: Edward Arnold. [Price 5*s.*]

Correction Tables for Thermodynamic Efficiency. By C. H. NAYLOR, M.Inst.C.E. London: Edward Arnold. [Price 5*s.*]

ENGINEERS are indebted to the turbine section of the British Electrical and Allied Manufacturers Association for the compilation of these extremely valuable tables.

As has been known for some time past the steam tables commonly in use, based upon the experiments of Knoblauch, Jakob and Linde, are erroneous, the values tabulated being inconsistent *inter se* and with thermodynamic principles. For example, the value of the specific heat of superheated steam as deduced from Knoblauch and Jacob's experiments differs by some 20 per cent. from the value obtained on thermodynamic principles, from the pressures, temperatures and specific volumes of the steam. The researches on which the tables in common use were based required, in fact, rather more insight and skill than was realised at the time. Even for steam at atmospheric pressure and near its staturation point the results obtained were substantially below the true value of 0.4856 at 104.5 deg. C., and at higher pressures, where the difficulties inherent in the method of investigation adopted were enhanced, the errors are still greater, being as much as 20 per cent. out. It is true that for certain practical purposes these errors matter little, but it is exceedingly disturbing to the investigator who attempts to make a detailed analysis of carefully conducted turbine tests to find serious discrepancies between the total heat-entropy estimate of the work due and that deduced from the equivalent indicator diagram. The publication of the Callendar steam tables and formulæ, in which all the tabulated figures are derived from expressions consistent *inter se* with thermodynamic principles and are in good agreement with the most reliable experimental observations, marked a new era so far as the theoretical aspect of steam engineering was concerned. The general adoption of these accurate figures will be greatly hastened by the publication of the heat-drop tables computed by Mr. Moss. The tables in the first of the two volumes referred to in our heading give the heat-drop available from all pressures between 400 lb. absolute and 50 lb. absolute, and for varying degrees of superheat up to 300 deg. F., on expansion down to various degrees

of vacuum ranging from 27 in. to 29.1 in. of mercury. A special table for use with exhaust steam turbines is provided for initial pressures of from 14 lb. to 19 lb. per square inch. The tables are excellently printed and very conveniently arranged, and will undoubtedly be found of great practical value. A useful addition would be a table for interpolating by second differences pasted on the inside of one of the covers; as we believe this would be found handier than the method of interpolation recommended in the preface. British thermal units have been employed throughout, a feature which will no doubt be regarded as a drawback by those anxious to extend here the use of the Centigrade system. This would undoubtedly have the advantage of making our engineering text-books and tables more popular abroad. The second of the two volumes differs from the foregoing solely in that the high-pressure tables are based on gauge instead of absolute pressures. This is a convenience for station engineers.

The correction tables for thermodynamic efficiency prepared by Mr. C. H. Naylor are based on the extremely valuable series of correction curves given by Mr. Baumann in his paper read before the Institution of Electrical Engineers in 1912. These have been extended to cover pressures up to 300 lb. per square inch (gauge), the range of superheat being from 50 deg. to 300 deg. F. Unfortunately no satisfactory theory of these corrections has yet been established, partly perhaps owing to a certain undercooling of the steam after its superheat is lost. The corrections are thus purely empirical, the advantage of the superheat being considerably greater than would be anticipated from the theory as usually given. The tables for high-pressure turbines have been compiled for 26 different vacua ranging from 27 in. to 29.1 in. The tables for exhaust steam turbines cover the same range of vacua, with initial pressures from 14 lb. to 18 lb. per square inch. These exhaust steam tables apply to saturated steam only, the superheat corrections for low-pressure steam being still perhaps a little uncertain. The standard of reference taken for high-pressure turbines is a stop-valve pressure of 180 lb. per square inch, a superheat of 150 deg. F., and a vacuum of 28 in. The tables give the factor by which the efficiency actually observed on trial must be multiplied in order to get the efficiency of the turbine if operated under standard conditions. The book will be of special value to station engineers, and will probably be extensively adopted in reducing acceptance test conditions to those formulated in the contract specification. Designers no doubt would find more serviceable a set of tables based upon the condition of the steam below the governor valve, rather than on the stop-valve pressures, but the condition at the stop valve very naturally forms the basis of most contract specifications.

BOOKS RECEIVED.

The "Syren and Shipping" International Mercantile Diary and Year Book, 1918. Planned and edited by A. M. POOLEY, B.A. London: *Syren and Shipping*, Limited, 91 and 93, Leadenhall-street, E.C. 3. [Price 5*s.* net.]

Munro's Marine Engineers' Annual Pocket Log and Diary. Compiled and arranged by JAMES K. MUNRO. Glasgow: James Munro and Co., Limited. [Price 1*s.* 6*d.* net.]

Scientific Research in Relation to Cotton and the Cotton Industry. Manchester: Offices of the Provisional Committee on Research and Education for the Cotton Industry, 108, Deansgate. [Price 9*d.* post free.]

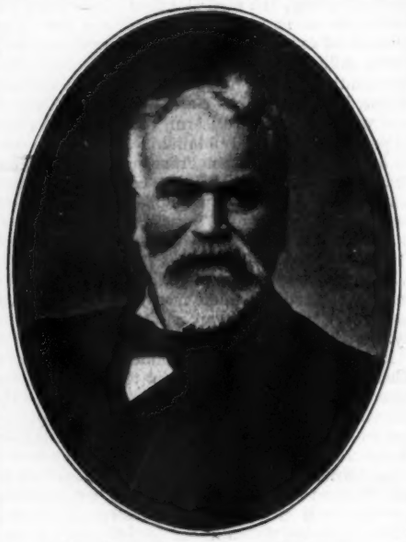
Points of Law for Business Men, being Decisions, &c., of the Courts for the Years 1916–17 Epitomised. Edited by JOHN ED. SEARS, J.P., and W. ERSKINE REID, Barrister-at-Law. London: The Compendium Publishing Company, 329, High Holborn, W.C. 1. [Price 5*s.* 4*d.* post free]

Women in the Engineering Trades: A Problem, a Solution, and some Criticisms; being a Report based on an Inquiry by a Joint Committee of the Fabian Research Department and a Fabian Women's Group. By BARBARA DRAKE. London: Fabian Research Department, 25, Tothill-street, S.W. 1, and George Allen and Unwin, Limited, 40, Museum-street, W.C. 1. [Price 2*s.* 6*d.* net.]

SHIPBUILDING ON THE PACIFIC COAST.—According to *The Marine Journal*, New York, 61 vessels, having an aggregate capacity of 279,380 tons, were built in North-West Pacific shipyards during 1917, and contracts for vessels to be built during this year will reach a much higher total.

THE LATE MR. JOHN F. M'INTOSH.

MANY engineers, particularly those associated with our railways, will share our regret on learning of the death of Mr. John Farquharson M'Intosh, who for 52 years was connected with the Scottish railways, and for nineteen years had served as the locomotive superintendent of the Caledonian Line. He retired in May, 1914, and continued to take a keen interest in locomotive work, but since December last he has been in indifferent health, and died at his residence in Pollokshields, Glasgow, on the 6th inst. Born in 1848, son of a tenant farmer on the Kinnaird Estate in Forfarshire, Mr. M'Intosh, at the age of 14, entered the works of the Scottish North-Eastern Railway Company at Arbroath, and there received a practical training in the manufacturing and running departments. About that time the Dundee and Arbroath Railway (a private line) was amalgamated with the Scottish North-Eastern, and on the completion of his apprenticeship, in 1867, M'Intosh was appointed to the Montrose Works, where he continued for ten years. The Caledonian company had absorbed the northern lines in 1866, and Mr. M'Intosh was an important link in the new chain of connection, so far as the personal management was concerned, as he had an intimate knowledge of all the systems in the north-east of Scotland. In 1876 an unfortunate accident deprived him of his right hand, but full scope for his mechanical knowledge and experience of the line was found in the position of locomotive



MR. JOHN FARQUHARSON M'INTOSH.

inspector of the northern section. In this position he continued from 1876 to 1882. He was then made district locomotive superintendent at Aberdeen, and was afterwards promoted to the very busy centre at Carstairs in 1884. Two years later he was advanced to the charge of the company's most important engine shed, that at Polmadie, Glasgow, and in 1891 he became chief inspector of the locomotive department of the whole system, with his headquarters at the St. Rollox Works, under Mr. Lambie, who was at that time manager. Mr. Lambie died in 1895, and Mr. M'Intosh succeeded him as locomotive, carriage and wagon superintendent, continuing in this position until his retirement in 1914.

Mr. M'Intosh had a sound mechanical instinct, and the locomotives he designed were regarded with high appreciation by all capable of judging. Practically immediately after his appointment he began to design a series of locomotives, beginning with the "Dunalastair," for the Glasgow and Carlisle passenger service, which gained for him high praise from all who had experience in locomotive design. The first type was exhibited at the Brussels Exhibition of 1897, and not only was it awarded the gold medal, but Mr. M'Intosh was invited by the Belgian Government to prepare designs suitable for the international express service on the State railways from Ostend. With the permission of the directors, he undertook this work, and a long series of the "Dunalastair" type of locomotives was the result. We have illustrated in ENGINEERING the successive developments of this type of engine, so that it is not necessary here to do more than merely mention them.* He introduced also new types of heavy goods traffic engines.† During the coal strike in 1912 he fitted oil fuel burning mechanism to some of the locomotives.‡ Later he made tests with superheaters on the locomotives. The developments were due not only to mechanical ability, but to a close investigation of the performances of the locomotives, with particular regard to load, gradient, speed, and coal consumption. He attached great importance to the collation of such data and to simple records in diagram form. Every performance of a main line train had to be recorded, and explanation found for any diminution in speed.

In his conduct of the works he was equally methodical and progressive, and in his relation with the men was most sympathetic. He had a fine faculty of adapting himself to all classes; he was ever genial, but firm, yet just, when occasion demanded it. All the schemes in the works found in him a personal enthusiast; notably, the friendly society of the locomotive department and the dining hall—a success long before the modern canteen was heard of—while the ambulance classes and popular lectures were supported in his usual direct way. It is scarcely necessary to say that he enjoyed the respect and confidence of everybody within the works as well as of the chairman and directors of the company.

He was a member of the Association of Railway Locomotive Engineers, and was president in 1911. He was connected also with other scientific societies. In 1911 King George created him a member of the Royal Victorian Order, and on learning of his retirement, although some months had elapsed, His Majesty sent a command requiring Mr. M'Intosh's attendance on one of the railway journeys in Scotland, in order that he might wish him good-bye. Mr. M'Intosh is survived by his widow and three sons and four daughters. One of the sons, Dr. Douglas M'Intosh, is serving with the Royal Army Medical Corps in Mesopotamia. Another, Lieutenant Gordon T. M'Intosh, of the Highland Light Infantry, is at present in hospital, wounded for the second time.

SHELL SPECIFICATIONS.—We read in *The Iron Age* that a meeting of representatives of the United States Government, the Allies and the various steel-making concerns interested in Government contracts for shell steel, was recently held at Youngstown, Ohio, to discuss the possibility of securing modifications in the specifications for shell steel with the result that it seems likely these specifications will be revised in such a way as will improve the quality of the steel and at the same time make possible a larger output than is now being obtained.

THE CÔTE-PIERRON ELECTRIC ZINC FURNACE.—According to the *Bulletin Technique de La Suisse Romande*, of November 17, 1917, a Côte-Pierron plant of four furnaces, each of 500 h.p. for 4,500 kg. of ore per 24 hours, was to be opened at Maurienne, near Epierre, this winter. The ores (blende and galena) do not require roasting; they are charged, mixed with lime and coal, into the compound furnace, which is a combination of an arc-resistance furnace and an indirect-resistance furnace; the former is the smelting furnace from which the vapours and drops of liquid metal pass into the second furnace, at once to be redistilled and condensed. The particulars given are very meagre. It is stated that a liquid metal of 99.93 per cent. of zinc is gained, with a loss ranging from 6 per cent. to 9 per cent., and that the electrode consumption is 12 kg. per ton of ore.

GERMAN ACTIVITY IN SWITZERLAND.—We read in *L'Industrie Electrique* for January 10, that the German organiser, Walter Rathenau, arrived in Switzerland two months ago, with a staff of 600 men. He immediately founded two companies, apparently under Swiss jurisdiction, styled "Militaria" and "Metallum." The former has for its object the co-ordination of war industries. The second company, "Metallum," shows up the monopolising activity of Germany. Rathenau is collecting in a trust the whole of the Swiss electric powers available, and this at a time when Switzerland is contemplating the electrification of her railways. Switzerland is tributary to Germany for coal; the quantity—200,000 tons monthly—which she was to receive from Germany greatly decreased long ago. Without coal, the Swiss railways will be at the mercy of Rathenau, who, in the near future, will be the sole producer of electric energy in Switzerland. The Swiss Confederation will then no longer control her means of transport, and the mobilisation of the Swiss army will be dependent on the permission of German financiers. The greater number of the 600 men whom Rathenau has brought with him to Switzerland are specialists lent by the German military authorities; the works he and they are to carry out in Switzerland will be conceived from a strategical point of view, and Switzerland is incapable of reaction owing to her dependence upon Germany in the matter of coal.

* Mr. M'Intosh's first tank engine was illustrated in ENGINEERING, vol. lxii, page 400; the Belgian locomotives in vol. lxvii, page 144, the three successive locomotives of the Dunalastair class in vol. lxix, pages 636 and 652, and their performance reviewed in page 772 of the same vol. Further locomotives of the class were described in vol. lxxiv, page 274, and vol. lxxxi, page 833.

† See ENGINEERING, vols. lxxii, page 275, lxxxii, page 299, lxxxvi, page 548.

‡ See ENGINEERING, vol. xciii, page 485.

THE RUSSIAN SALT INDUSTRY.

SALT is found in Russia in immense quantities, under all known conditions, in salt lakes and bays, underground, and as rock or stone salt. The aggregate production of salt in Russia now amounts to about 2,000,000 tons per annum, of which about half comes under the first head, the balance being fairly evenly divided between the second and the third. For the year 1913 the production was divided amongst the different parts of the country in the following proportions :—

	Per Cent.
Donetz basin	32
Astrachan	25
Ural...	20
Crimea, 15 per cent.	17
Odessa, 2 per cent.	
Siberia	2
Caucasus and Transcaspia	3½
Poland and Northern Russia	½

Most salt is found in the southern portion of the country, more especially in the districts round the Donetz. The greater portion of the rock salt comes from thence, amounting in 1913 to 630,000 tons, of which 75 per cent. were rock salt and the 25 per cent. derived from springs. In the year 1876, in borings for salt springs, an immense layer of salt, of 120 ft. thickness, was come upon at a depth of 350 ft. ; these deposits are situated close to the little town of Bachmuth, in the Government of Ekaterinoslov. There are also salt springs in this part of the country, and salt from springs is likewise being produced at the town of Sloviansk, in the Government of Charkow, where the boreholes have a depth of 250 ft. to 1,000 ft.

The Government of Astrachan comes next to the Donetz basin, with one-fourth of the aggregate production of salt in Russia. This industry dates from the seventeenth century, and the salt is still exclusively produced from lakes, of which there are over 300, although only a few are of any industrial importance. The principal production of late years has taken place from the Baskuntschak Lake, situated 7 km. from the Astrachan Railway and 50 km. from the Volga, with which there is direct railway connection. The location, consequently, is favourable, and the lake is estimated to contain 2,000,000,000 tons of salt. In the spring, the water of the lake is like brine, only 1 ft. deep, and during the summer it evaporates entirely ; salt is found to a depth of 60 ft. from the surface, and at a depth of but a few feet, the salt is white and large-grained ; it contains as much as 98 per cent. chloride of sodium. During the last ten years the production has averaged 430,000 tons.

The Ural claims the third place, and salt is there found in all forms ; the salt springs, however, yield 88 per cent. of the total production, which again represents about three-fourths of Russia's entire production of salt from springs. In the Ural it is especially produced in the Government of Perm, from some 60 boreholes, varying in depth from 500 ft. to 700 ft. The strength of the brine amounts to 19 deg. to 24 deg. Baumé. Most of the factories are situated at the river Kama, which joins the Volga, so that a convenient waterway for transport is near at hand.

Rock salt is found in the Government of Orenburg, at the Ilezskaja Saschita station, and these salt deposits are being worked in a rational manner with shafts and underground tunnels. The extent and the depth of these salt deposits have not yet been gauged, but the portion so far examined is calculated to contain at least 1,500,000,000 tons. The salt is very pure, containing 99 per cent. pure chloride of sodium. The annual production averages some 40,000 tons. The works are entirely modern, and the production could easily be quadrupled, did not the transport difficulties stand in the way.

Fourth on the list of salt-producing districts in Russia comes the country in the neighbourhood of Lake Azof and the Black Sea in the Government of Taurius, especially in the Crimean peninsula, and in the southern part of the Government of Bessarabia and in the Government of Cherson, 7 km. from Odessa ; the production is principally confined to the salt lakes. The Crimea supplies about 15 per cent. of Russia's aggregate production, most of it coming from the districts at Eupatoria ; the production from the two largest lakes is respectively 60,000 tons and 40,000 tons per annum, and the total production of salt in the Crimea amounted to about 300,000 tons in 1913.

As far as Siberia is concerned, there are numerous salt lakes in the western portion which dry up in warm summers, leaving salt layers of a few inches thickness and in the eastern portion there are salt springs, and in some places rock salt. The aggregate production, however, only amounts to some 30,000 tons to 40,000 tons per year.

Salt is found in several places in the Caucasus, but the production is only of local importance ; also in northern Russia and in Poland a small salt production takes place.

Important as is the Russian salt industry at present, it is, no doubt, capable of considerable further development ; some import still takes place, some 70,000 tons in the year, most of which comes from Germany and from China and Mongolia, a small portion also coming from England ; the imports amount to about 4 per cent. of the home production, and the export is entirely insignificant, only amounting to 11,000 tons in 1913.

"THE SINS OF THE CAPITALIST."

TO THE EDITOR OF ENGINEERING.

SIR,—All those who have had their nose against the grindstone for many years, and know what it is to have carried on a fairly large works under the adverse conditions of the free, competitive system of the past, must with me, very much appreciate your able article on the above subject, and I hope that Mr. W. L. Hichens may have had time to have read it.

The inexperienced and foolish people who are out for the conscription of capital are only too glad to make use of the remarks of such philanthropically-disposed employers as Mr. Hichens, so far as they may seem to support their ideas, and without quoting the qualifying statements you refer to.

I notice you speak of 6 per cent. as being the average dividend of engineering concerns. Mr. W. Rowan Thomson, in his book on the premium bonus system issued in 1917, says that Mr. Gerald Stoney in his presidential address to Section D of the British Association, in 1916, stated that the capital employed in the engineering trade averaged 200*l.* per individual employed, and that the dividends paid averaged 4 per cent. only. I think we may take it that this statement is perfectly correct, and it means that assuming the standard wage was 100*l.* per year before the war, an advance in such wages of only 8 per cent. would have entirely swept away the dividend of 4 per cent. on the 200*l.* of capital employed per man.

I think that too great publicity cannot possibly be given to such an important fact as this.

Yours truly,
H. M. BUTLER
(Managing Director).

Kirkstall Forge, Leeds, February 12, 1918.

[We took 6 per cent. so as to be absolutely on the safe side and to avoid all possibility of being accused of overstating our case. Our words were : "We very much doubt whether the engineering limited companies pay, on the average, as much as 6 per cent. on their aggregate capitals, including preference and debenture stocks." We are indebted to Mr. Butler for calling our attention to the words of such an able authority as Mr. Gerald Stoney, whose address was published in our issue of September 8, 1916, page 238.—ED. *E.*]

GERMAN METHODS OF GAS-ENGINE DESIGN.

TO THE EDITOR OF ENGINEERING.

SIR,—From my letter in your last issue it will be understood that—

$$\frac{M\,E\,P.}{3\,p\left(1+\frac{v}{s}\right)\left(\sqrt[3]{\frac{v+s}{v}}-1\right)}=\left(\frac{C}{15\left(\frac{C}{U}+1\right)}-1\right)$$

It also

$$=\left(\frac{P^x}{P^c}-1\right).$$

where P^x = explosion pressure and P^c = compression pressure } in pounds per square inch absolute.

It is worth noting that these factors are a complete explanation of the mystery brought to the notice of the members of the Institution of Mechanical Engineers in January, 1914. It is even more worth noting that both these factors have been published annually for the last fifteen years in Fowler's "Mechanical Engineer's Pocket-book." I contributed them. As your readers will no doubt desire to know something regarding the basis of these factors I would direct their attention to a fact that is not quite so well known as it should be, viz. :—

"The thermal value of all combustible mixtures containing only the quantity of air required for the complete combustion of the fuel is, for all practical purposes a constant, the value of which is 120 British thermal units per cubic foot of air used." Or, conversely : "The number of cubic feet of air required for the complete combustion of any fuel equals the calorific value in British thermal units divided by 120."

This applies to either gaseous, liquid or solid fuels, and may be used where the calorific value is given by volume or by weight, indifferently.

I notice the stroke volume formula given in my last is not complete. It should read :

$$S\,V=\frac{2545\ BHP.\ 2}{U.\ TE.\ N.\ R.\ 60}$$

Yours truly,
JAS. DUNLOP.

190, Bellfield-street, Dennistoun, Glasgow,
February 9, 1918.

PATENT LAW REFORM.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent, Mr. James Keith, deserves many thanks for his efforts on behalf of inventors.

The nation has not in the past realised how dependent it is on its inventors and partly for this reason it has lost its lead over rival nations.

I have not much fault to find with the present scale of Government fees for reasons which I will mention later, but our patent office search is a ludicrous absurdity compared with either the American or German searches. It is of the "utmost importance" that inventors should have a ready means of finding out whether their invention is new or not as soon as possible so as to save money and time in those cases where they have been forestalled (which is very often the case), thus allowing their money and time to be devoted to working out really novel inventions. Those who are responsible for allowing the search of our Patent Office to be restricted to prior British specifications are guilty of a "penny wise and pound foolish" policy. By such means the Patent Office has in the past been able to pay about 100,000*l.* per annum towards the revenue, but at a disadvantage to the country of at least 10,000,000*l.* per annum. When will our rulers show a little more sagacity ? Let us in any new Act make this search business a very strong point—let us try to beat the Americans and Germans in this direction.

The application fees might, perhaps, be lowered a little, but I suppose that even poor people can generally afford to pay the present Government fees (only 5*l.*, including the sealing fee), and it should not be forgotten that a fairly good fee tends to prevent the patenting of too many trifling ideas. The renewal fees should not in my opinion be altered much (excepting that for the present due to the war they should not be payable—it is another crime on the part of the authorities that they are still in force). The very good reason why renewal fees should be enforced in normal times is that by this means the valueless patents are often made invalid through non-payment of renewal fees, thus in some cases clearing the way for an inventor who really does know what he is doing.

Compulsory working and practically compulsory use of patent agents I regard as a short-sighted imposition on inventors. When inventors get rich they prefer to make use of the patent agents for convenience's sake, but it should not be necessary for a poor man to go to any agent, if he has himself had any reasonable amount of education. Pains should be taken by the authorities to see if this result can be achieved.

Yours faithfully,
W. C. M. PETTINGILL.

Rochester, February 11, 1918.

RETIREMENT PROVISION FOR MARINE ENGINEERS.—At the meeting of the Institute of Marine Engineers held on Tuesday last, the 12th inst., a paper was read by Mr. W. W. Houfe on this interesting subject. The author discussed in great detail the principles of contributory retiring allowances on the annuity system, and from this point of view the paper was of much value. Mr. Houfe, however, did not attempt to lay down any definite scheme, treating the subject rather on broad academic lines and in an equitable manner, with due consideration of the position of employers and employees. That some form of retiring allowance should be arranged for in all steamship lines, and not only in a few, is accepted, but the difficulty is in arriving at a fair method of contribution, so that the data given by Mr. Houfe may form the basis for arranging a definite scheme of application.

THE JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY.—The Journal of the Society of Chemical Industry, always of a very high standing, has, with the beginning of this year extended its scope. So far it had confined itself to the Transactions of the society, to the publication of the papers brought before the various sections of the society, of abstracts of foreign papers and patents, and of trade reports and other matters of interest to chemists. The new section of the Journal called the "Review" will include articles of general and industrial interest, contributed by experts, official and trade reports, company reports, Parliamentary and legal intelligence, reviews of books, and further reports of the proceedings of other societies, in so far as they touch chemical industry. There will hence be some new features and an extension of old approved activities. A very good beginning has been made with No. 1 of vol. XXXVII ; there will be two issues of the Journal every month as before ; the number of the volume indicates the number of years for which the Journal has been appearing.

GAS TRACTION PROGRESS.—Evidence has been laid before the Gas Traction Committee by manufacturers of flexible gas containers, according to which some 4,500 commercial motor vehicles have already been equipped to use coal-gas instead of petrol. Orders for an additional 2,500 flexible containers, all for business vehicles, are in hand at the moment for completion during the next few months. The evidence shows that under 4 per cent. of the total deliveries to date have been to owners of private motor cars, whilst no further orders in this category are being taken, and that practically the whole of the manufacturing processes are being carried out by woman labour. The estimated saving of petrol, due to the substitution of gas, is already at the rate of approximately 3,000,000 gallons annually. The Gas Traction Committee, which was appointed with Sir Boverton Redwood, Bart., as chairman, at the end of November, is sitting weekly, and hopes shortly to issue an interim report. All communications concerning the technical investigations of the committee should be addressed to the Secretary, Mr. E. S. Shrapnell-Smith, Chief Economy Officer, H.M. Petroleum Executive, 8, Northumberland-avenue, London, W.C. 2.

STANDARD SHIPS AND ENGINES.

THE Shipping and Shipbuilding Industries Committee has submitted its report on the subject of standardisation. Sir Alfred Booth was chairman of this committee, the other members being Professor Abell (Lloyd's Register), Mr. James Brown (Greenock), Sir G. S. Clark (Belfast), Sir Archibald Denny (Dumbarton), Captain Hooper (London), Mr. Summers Hunter, Mr. James Readhead, and Mr. Oswald Sanderson (North-East Coast) and Mr. J. A. Roxburgh (Glasgow). The committee state :—

"Standard vessels and standard engines have been designed and are being built by a large number of firms, and the experience gained so far indicates that under normal conditions successful results might be achieved on similar lines. It should, however, be borne in mind that after the war efforts at increased standardisation will rest with individual builders and not with the Government. Standardisation had been carried to considerable lengths before the war in details of outfit, and even to the extent of building complete standard designed vessels. Generally, however, standardisation had been carried out works by works, and naturally in ordinary cargo boats alone. As in the case of the hulls of cargo vessels, so with marine engines, a considerable amount of standardisation has been effected within the works of individual firms building marine engines, and we learn from the evidence of one of the witnesses that an effort is being made further to standardise marine engines of the reciprocating type for cargo vessels. This standardisation has taken the form of a guidance specification, and is being drawn up under the auspices of the North-East Coast Institution of Engineers and Shipbuilders. In any type of engine such as is adopted for the plain cargo boat, where the general design is similar, differences being chiefly of detail, the universal use of such a specification should tend to an increase and cheapening of production. In the case of turbines and oil engines, where design is still in the early stages of development, standardisation is more difficult, but should be attempted."

In its recommendations the committee says :—

"We view any movement towards standardisation with satisfaction, and we are of opinion that further effort should be made to secure progressive standardisation in all directions. We are aware of the very valuable work which has been done by the Engineering Standards Committee for the benefit of shipbuilding and marine engineering, in which work shipbuilders and engineers have taken a large part, and we therefore recommend that the Government suggest to shipowners, shipbuilders and marine engineers the desirability of forming a Joint Committee under the Engineering Standards Committee to consider these proposals. Shipbuilders and marine engineers who gave evidence before us considered that the question of increased standardisation of production depended largely upon shipowners and their marine superintendents, and that it had not hitherto been practicable to carry it so far as it could have been had shipowners and their technical advisers been prepared to forego insistence on their own ideas in general design and details. It is for this reason that we recommend that shipowners (or their representatives) be joined with shipbuilders and marine engineers on the above Standards Committee. We recognise, however, that even so far as cargo-carrying vessels are concerned the extent of standardisation as to dimensions and general design must necessarily be limited in ordinary peace times by difference of the draught of water at various ports, variations in the methods of loading and discharging cargo, the nature of the cargo itself, speed requirements &c."

A NEW MATERIAL FOR MAKING PAPER.—According to *Canadian Machinery*, a new material for making paper has been found in Zacaton grass, known also as broom-root grass and wire grass. The tops, which hitherto had gone to waste, have been found to yield a fine grade of paper. An acre of grass should give at least 3 tons of tops. The plant is a perennial one, the growth being almost entirely from self-sown seed. Tests have shown that the material can be chemically reduced to paper stock by the soda process more easily and with less expense than is necessary to reduce poplar wood.

THE DECREASE IN BRITISH CANAL TRAFFIC.—According to *The Board of Trade Journal*, a considerable falling-off had occurred in the amount of canal traffic during the war period before the canals were taken over by the Board of Trade. The extent of this fall in the case of the more important canals is shown in the following table :—

Canal.	Tons Carried. 1913.	1916.
Aire and Calder Navigation	3,598,000	2,095,000
Birmingham Navigation Canals	7,090,000	6,600,000
Bridgwater Canal ...	2,204,000	1,642,000
Gloucester and Berkeley Canal	1,022,000	543,000
Grand Junction Canal...	1,668,000	1,236,000
Regent's Canal	967,000	746,000
Weaver Navigation ...	1,134,000	835,000
Staffordshire and Worcestershire	722,000	566,000

The total traffic conveyed by all the canals in England and Wales before the war was about 33,000,000 tons, of which the canals, now under the control of the committee, conveyed some 25,500,000 tons. In 1916 the total traffic conveyed by canals had fallen to 20,500,000 tons. The figures of the traffic conveyed in 1917 are not completed, so that they cannot at present be given. But the very serious drop in the traffic has been arrested.

OFFICIAL SYSTEM FOR STEEL SUPPLY.

THE following communication has been received by us from the Admiralty :—

Inasmuch as there appears to be considerable confusion and want of knowledge as to the procedure to be followed in obtaining supplies and the reason for the institution of the procedure, it is thought that the following brief explanation will be of considerable assistance to your readers.

Briefly, as is perhaps generally known, the demand for steel is far in excess of the possible supply, and in order, therefore, to ensure that available supplies shall as far as possible be forthcoming for the most urgent work, a system of control of rolling has been instituted in conjunction with the Ministry of Munitions.

The country has been divided up into six areas, each of which has been placed in charge of a steel superintendent, who represents the Admiralty and the Ministry of Munitions. One of his chief functions is to advise and assist firms located in his area in obtaining the supplies of steel needed by them for authorised purposes, and it is, therefore, incumbent on all firms requiring supplies to consult with their steel superintendent and follow his directions. The six areas in question are known as the Scotch Area ; the North-East Coast Area ; the Sheffield Area ; the Manchester Area ; the

Birmingham Area ; and the South Wales Area ; and the accompanying rough map illustrates the boundaries of the said areas.

The rolling programmes at the principal works of the areas in question are arranged by the steel superintendent in consultation with expert Area Committees composed of representatives of the principal mills, and it follows that the steel superintendent, who is in constant communication with his colleagues in the other areas, is in a position to give authoritative information as to the prospects of obtaining material. To facilitate regular and frequent rollings of sections, thus avoiding serious delays, a list of standardised sections (see page 175) has been drawn up and published for information, and if firms confine their requirements for sections to the list in question there should rarely be any delay in obtaining supplies necessary to enable work to proceed with promptitude. The needs of the various services and the country generally have been carefully estimated, and the available supplies have been allocated *pro rata* thereto. In order to ensure that the supplies available do, in fact, go to the allotted destination, statistical returns are regularly obtained from all the manufacturers, which give particulars of all their deliveries to their various customers, and in order to enable these returns to be utilised, the system of what is known as "Prefix lettering" for orders has been instituted. These prefix letters indicate the service for which the steel ordered thereunder is to be used, and it has been laid down that no order may be entered or executed unless it bears its appropriate prefix lettering followed by the Admiralty or Ministry of Munitions priority or permit reference. All material destined for Admiralty purposes, including every species of floating craft, is dealt with under Admiralty prefix lettering and contract or permit number, and all the remaining services are dealt with under Ministry of Munitions prefix lettering and contract or permit numbers or references.

From the following it will be seen that any failure to comply strictly with the procedure indicated above must of necessity lead to confusion and delay.

Where a main contractor receives a contract which it is necessary to sub-let, it is imperative that his sub-orders and those of all sub sub-contractors, &c., should bear the prefix lettering and reference allotted for the main contract. It should be particularly noted that the intention is that as far as practicable every area must be self-supporting, that is to say, firms within an area should obtain their supplies of steel from manufacturers in their area, and it is particularly necessary that firms outside Scotland should not obtain materials from that area and *vice versa*.

In view of the vital importance of shipbuilding, it is necessary that the rolling mills producing large-sized plates suitable for shipbuilding should have the demands upon their capacity for plates for other than shipbuilding purposes reduced to a minimum, and it is necessary, therefore, that the capacity of what are known as "Re-rollers," that is, firms who do not manufacture their own steel, but who purchase semi-finished material for rolling down, should have their capacities utilised to the utmost possible extent. Such firms produce plates and sheets limited in size and area, and it has been found necessary to adopt as far as practicable standard sizes of light plates to meet their technical difficulties. Such standard sizes are : Plates, 8 ft., 10 ft. and 12 ft. long by either 3 ft., 3 ft. 6 in. or 4 ft. wide, in any of the following thicknesses, viz., $\frac{1}{4}$ in., $\frac{5}{16}$ in. and $\frac{3}{8}$ in., and consumers are particularly recommended to employ these plates wherever practicable in their designs, even although a certain amount of increased cost and workmanship is involved in so doing.

If this be done, much of the difficulty and delay which has been experienced in obtaining supplies of thin and light plates will be removed.

The names, addresses, telegraph and telephone numbers of the six steel superintendents are annexed :—

Names and Addresses of H.M. Steel Superintendents.

Name.	Address.	Telegraphic Address.	Telephone No.
Scotland—			
Mr. G. P. West	105, West George-st., Glasgow	Steeladmir, Glasgow	6523 Central, Glasgow.
North-East Coast—			
Mr. H. J. Eastcott	Milburn Ho. (Floor D), Newcastle-on-Tyne	Steeladmir, Newcastle-on-Tyne	988 Central, Neweastle-on-Tyne.
South Wales—			
Mr. T. G. Rogers	Prudential Buildings, St. Mary-st., Cardiff	Steeladmir, Cardiff	2413 Cardiff.
Midlands—			
Mr. C. Wallis	Phœnix Buildings, Colmore-row, Birmingham	Steeladmir, Birmingham	1851 Central, Birmingham
Sheffield—			
Mr. H. A. Clift	Bank Court Chambers, 7, Bank-st., Sheffield	Steeladmir, Sheffield	917 and 918 Central, Sheffield.
Manchester—			
Mr. W. H. Jago	Royal London Buildings, 196, Deansgate, Manchester	Steeladmir, Manchester	7177 City, Manchester.

AMERICAN RAILROAD EQUIPMENT.—According to *The Iron Age*, New York, an important result of the Government supervision of railroad operation undoubtedly will be a great reduction in running inventories of repair materials for rolling-stock. Interchangeability will be the order of the day. It will be demanded so as to expedite manufacture of the large numbers of cars which under Government financing are expected soon to be bought. The appointment of railroad experts in charge of given districts is expected. Then the needs of the different districts will be scheduled, and finally a distribution will be made of the calculated number of cars, all to the same general model for a given type, but with such latitude as to couplers, draught gear, brake beams and other features as will preserve interchangeability and at the same time work for maximum output. In connection with output, it must be remembered that while the car builders have not been operating at 50 per cent. capacity, and for this thanks to business for foreign roads, they have had to enter war business, such as making shell forgings, and with much dislocation of organisation. This will make increased output difficult in the face of diminishing labour supply. While it is announced from Washington that existing purchasing organisations of the roads will continue to provide for their separate needs, it is to be expected that large tonnage purchases of cars, locomotives and rails, affecting in an important way the country's productivity, will be under central control. At any rate, adds *The Iron Age*, central authority will demand interchangeability, and no longer will a South-Western line need to carry in stock ten types of a thing for repairing cars which are doing duty on a road in the North-West. Here, as in many other lines, the national demand for economy will break the designers' habit of stamping his creations with modifications of a non-essential character.

TRACTION ON BAD ROADS OR LAND.*

By L. A. LEGROS, of Acton, Member.

(*Continued from page* 148.)

SOME further particulars of the characteristic features of the several types may now be given.

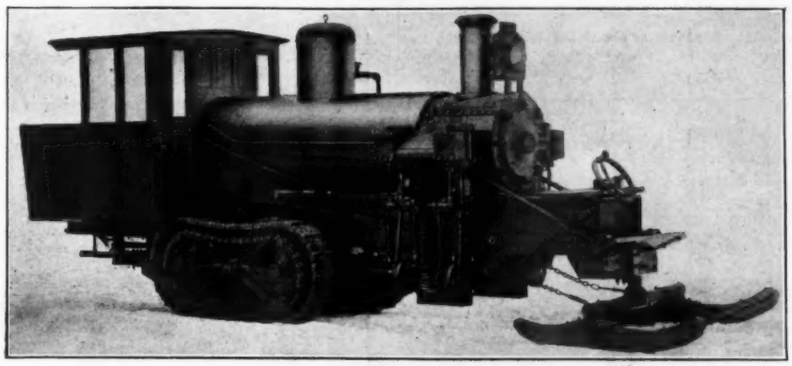


FIG. 59.

FIG. 60.

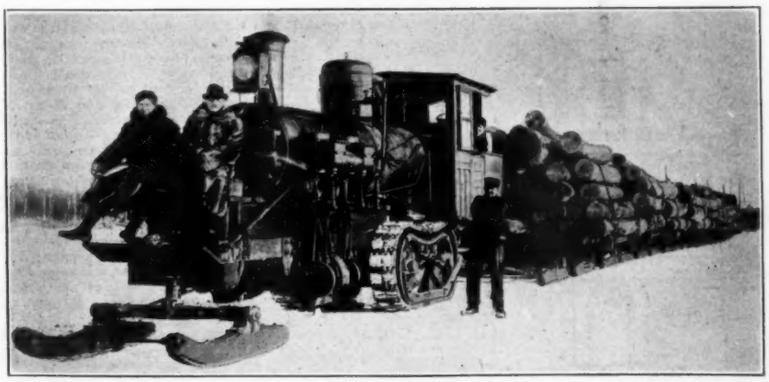


FIG. 61.

FIGS. 59 TO 61. THE LOG HAULER (PHŒNIX).

The Log-Hauler, Phœnix.—The Log-Hauler (Phœnix) was first used in 1904, and engines of this class were supplied to Montana in 1906; many are in use in Wisconsin. One of these vehicles is shown in Fig. 59, annexed. In early logging a team of four bullocks hauled a sleigh carrying about 1,500 ft. of timber, or a weight of about 8 tons. The present-day sleigh is from 7 ft. to 8 ft. wide from centre to centre of runners, with cross bunks, 12 ft. to 16 ft. apart, on which loads are built up, Fig. 62, Plate XIV; the load for an individual sleigh amounts to from 5,000 ft. to 7,000 ft., and the train consists of from seven to fifteen sleighs, or a weight of 200 tons to 420 tons.*

The Log-Hauler has a locomotive-type multitubular boiler with barrel 15 ft. long, 36 in. diameter, and 1.75-in. tubes, the working pressure being 200 lb. per square inch. Coal or wood fuel is used. The engines are vertical, with two double-acting cylinders, 6.25-in. bore, 8-in. stroke, with link-motion reversing gear on each side, Fig. 60, annexed. Each drives through spur gearing into a lay shaft which itself drives at the back through a bevel pinion into a bevel wheel fixed to a spur wheel which is free to revolve on the back axle. This spur wheel gears through an intermediate spur wheel into the rear sprocket, Fig. 60, given herewith; the front sprocket is an idler. The back sprocket gears into the outer or lag-chain of shoes, which is the track chain; the centres of the pins are about 2 in. from the face of the shoe, which is fitted with a ∧ projection to grip the frozen surface on which the Log-Hauler travels. There is no special provision in this case for guarding the joints of the chain track. A screw adjustment is provided for taking up stretch of the lag chain by acting on the front sprocket bearings. There are two intermediate roller chains with case-hardened rollers 3 in. diameter and about 2 in. wide for each track; these roller chains run on tool-steel guides secured to the underside of the truck frame, and are guided at the sides where they pass over the carrying segments. Lateral pressure is taken on the sprockets. The speed of running is from 4 to 5 m.p.h. The load hauled depends not only on the grading of the road but on how well it has been iced. The crew consists of the engineer (driver), a fireman, and the pilot; the latter sits in front of the smoke-box, so that he can see both the road and the runners, Fig. 63, Plate XIV. The steering column is inclined backwards, and drives through a worm into a cross-shaft which is connected by chains to the ends of the cross-beam of the runners. The coal consumption is stated to be from 56 lb. to 84 lb. per mile. The tractors have to haul their own water supply, and may also be required to plough the track clear of snow. Provision is made for attaching a snow plough clear of the runners.

The illustrations, Fig. 61, annexed, and Figs. 62 and 63, Plate XIV, show the methods of building up the loads and trains of sledges both for log and sawn timber; they also show the small ground clearance allowed in this particular type of tractor, and the curve that can be taken by the train.

The Centiped Truck, Phœnix.—The Centiped, Fig. 66, Plate XIV, resembles the Log-Hauler in the pivotal arrangement of the track frames, and in the construction of the lag chains and roller chains. Both axles are carried on springs. The steering is of the Ackermann type with the front axle pivoted about a horizontal axis, so that the vehicle has virtually a three-point suspension, and either front wheel can be taken over an obstacle 10 in. high. This is a very necessary feature in tractors fitted with two front wheels, as they are frequently required to cross ditches obliquely, Fig. 68, or banks of railway tracks, Fig. 69, Plate XIV. Examples of the Centiped at work are given in Figs. 71 and 72, Plates XIV and XV. Power is transmitted through a three-speed and reverse gear-box to the differential shaft, and thence to the rear sprockets in a manner similar to that adopted in the Log-Hauler.

The track adjustments, Fig. 70, Plate XIV, are of the same type as on the Log-Hauler, but the construction of the chain track is different. The centres of the pins are usually far from the face of the shoes, this dimension being about 5 in.; but to avoid nut-cracker action each shoe overlaps the one in front by about 2.5 in. on the flat and 1 in. at maximum curvature. Each shoe carries a strake about 2 in. wide by 1 in. thick. The small amount of sinking of the track on soft sand, as compared with that of the wheels, is shown in Fig. 67, Plate XIV.

The Allis-Chalmers Tractor Truck.—This vehicle, Fig. 73, Plate XV, closely resembles the Centiped in general arrangement of gears as well as in the design of the chain-tracks and of the roller chains. It is fitted with an engine of higher speed, of 68 brake horse-power, and is peculiar in having four forward speeds, the third speed on direct drive giving about 6.2 m.p.h., and the indirect-driven fourth as high as 7.5 m.p.h. The springing of the front axle is effected by two heavy coil springs; the back axle is carried on two side springs of the semi-elliptic sliding type, each 54 in. long by 3 in. wide, and supplemented by a cross-spring, 30 in. long by 3 in. wide. The front wheels run on roller bearings. A special feature of the design is the large road clearance permitting the vehicle to be used over very rough ground or in deep snow. The Allis-Chalmers tractor weighs about ½ ton more than the Centiped, but has approximately the same insistent weight.

The Caterpillar (Holt).—The load is carried in the Caterpillar (Holt) from the central portion of the chain on five pairs of chilled cast-iron flanged wheels. The wheels run on heat-treated steel axles fitted with Hyatt roller bearings. The pairs of wheel flanges are alternately inside and outside the bearing surfaces of the track chain. The track links are either of annealed steel castings, as in the 120-h.p. model, Fig. 57, page 147 *ante*, or are built up of steel drop-forgings machined on the upper face, Fig. 56, and secured to pressed steel sole plates; the shoes have each two corrugations about 1.5 in. wide for gripping the ground; the pins are of case-hardened steel. The bearing faces are 2.5 in. wide in the 75-h.p. and 2.35 in. in the 45-h.p. model. As there are two lines of rail surfaces on each chain, the total effective rail width is 10 in. for the 75-h.p. and 9 in. for the 45-h.p. models respectively. The truck in both the 120-h.p. model, Fig. 74, Plate XV, and in the 75-h.p. model, Fig. 75, Plate XV, and Figs. 86 and 87, Plate XVI and Fig. 88, page 186 is in a single piece, and is connected to the axles by two links, of which the front

* Paper read before the Institution of Mechanical Engineers on Friday, January 18, 1918.

* We regret that owing to the demands upon our space it is not possible for us to reproduce in ENGINEERING all the illustrations showing different types of tractors at work which accompany Mr. Legros's paper.

one is fitted with a screw adjustment but is allowed freedom for vertical movement relatively to the track frame; the load is carried by four double-coil helical springs on each side. The unsupported portion of the chain track between the sprocket or idler and the adjacent wheel at each end is about 1½ links in length. The steering is effected by a single front wheel controlled by a non-reversible worm and wheel gear.

Power is transmitted from the engine through a multiple-disc clutch with five plates, bronze to cast-iron, to a simple reversing gear-box with two speeds and reverse; the drive-shaft is spring-driven to reduce shock in taking up the load; the track sprockets are driven by chains; there is no differential gear, but friction clutches are fitted on both sides so that the drive may be on either side to facilitate turning.

In the smaller models, 45 h.p. (Fig. 76, Plate XV, and Figs. 89 and 90, page 187), and 18 h.p. (Figs. 78 and 79, annexed), there is no front wheel, and the steering is effected entirely by separate clutches and brakes; the turning radius is controlled by pressure on a foot pedal. The truck frame is itself articulated in these models, Fig. 51, page 146, *ante*, the leading half of the truck having two-wheel axles and the back half three-wheel axles, in both the 45-h.p. and 18-h.p. models; the springing of the back half of the truck from the main frame is very similar to that adopted in the larger models, but the front halves of the truck are connected by pin joints to a transverse compensating beam pivoted horizontally and axially with the vehicle, Fig. 91, Plate XVI, so that actually there is a three-point suspension and freedom for the truck frames to accommodate themselves to irregularity of the ground.

The Clayton Tractor.—This tractor, Fig. 92, Plate XVII, was produced by Messrs. Clayton and Shuttleworth jointly with Mr. W. F. Rainforth, Director of the Munitions Mechanical Transport Department. It is the sole representative of high-power chain-track vehicles of British design and manufacture, has fixed centres for the sprocket and idler as in the Caterpillar (Holt), but the arrangement of the truck is different, a single link connecting the truck to an anchor pin fixed to the track frame, Fig. 48, page 144, *ante*. The load is carried on each truck by two inverted laminated springs about 2 ft. long, each consisting of 10 plates, 3 in. by 0.3 in., Fig. 95, Plate XVII.

There are seven supporting wheels, alternate wheels being flanged; those next the driving sprocket and the idler are without flanges. The length of chain unsupported between the end wheels and the sprocket or idler is nearly two chain-links in length. The links are built up of steel castings and pressed-steel shoes, Fig. 95; the latter have a central corrugation about 2 in. wide by 1.5 in. deep. Another corrugation is formed in the end of the sole plate that laps over the succeeding plate. The pin centres are kept very low, being only 2 in. from the under surface of the sole. An adjustment is provided for the bearings of the idler axle to take up wear.

The steering gear of this tractor is quite original in pattern, and consists of a single front wheel carried at the end of a projecting boom, Figs. 96 and 97 page 187. This is capable of being raised or depressed through a range of 15 deg. each way from normal, so that its position in relation to the track can be adapted to severe irregularities in the ground; it is not, however, necessary to use the elevating gear otherwise than for approximate adjustment, as a spring gear is fitted which provides for the range of movement in each direction.

Power is derived from a 110-h.p. petrol engine, constructed by the National Gas Engine Company, Limited.,* and is transmitted through a multiple-disc clutch with seven steel plates bearing on ferodo surfaces; the clutch shaft runs on ball bearings. A flexible coupling with tripods connected by triple leather discs provides for possible errors of alignment between engine and gear-box, Fig. 98. The gear-box has three forward speeds and a reverse, change of gear being effected by means of the usual motor tractor sliding gear to a worm shaft, Fig. 99; the latter drives into a bronze worm wheel, inside which the differential-gear pinions are carried. The differential bevels are each formed in one with a short hollow shaft, the interior of which is bushed to receive a short independent shaft, on which the worm-wheel centre is free to revolve. The ends of the bevel-wheel shafts are squared, and each fits into a driving pinion, which carries a brake drum on its inner side and engages with the gear wheel attached to the twin sprockets. The sprockets are spigoted and bolted together, and to the spur wheel, and the whole arrangement is bushed and runs on the fixed back axle. All shafts are fitted with lubricating devices for enabling grease to be forced between the bearing surfaces. In each chain there are four bearing surfaces for the wheels, each 1.5 in. wide, giving an aggregate carrying width of 12 in. for the two tracks.

Steering is assisted by applying brakes independently to the pinion brake drums.

The Clayton tractor is shown in Fig. 93, Plate XVII, hauling a test load, and in Fig. 94, climbing a 40 deg. gradient; the illustration shows how the front wheel leaves the ground at the top of the grade. The shock that would occur when the bank is climbed, and the machine again assumes the level, is in greater part or entirely absorbed by the springs controlling the projecting boom, Figs. 96 and 97, page 187.

The 35-h.p. Clayton tractor, Fig. 100, page 188, resembles the smaller American models in the absence of a front wheel; steering is effected by clutches and brakes operated through a steering wheel.

The change gear provides two speeds forward and one reverse, and drives through clutches into two lantern pinion carriers on the driving shafts, each gearing with its respective driving sprocket; the sprocket engages with the chain-track pins in every third tooth.

Each chain track supports the vehicle through four fixed-axle wheels, the slack of the chain being carried on a single wheel; each chain passes over an idler at the front of the vehicle.

The tracks are pivoted about the driving shafts, the load at the front end being carried on a front axle which allows the two tracks to move independently of each other, and by means of a special connection, to move only in a vertical path.

The Tracklayer (C. L. Best).—In both the 90-h.p., Fig. 101, page 188, and 75-h.p. Tracklayers the power is transmitted from the engine through an expanding clutch and flexible spring coupling to the transmission gear-box, which is of the usual sliding-gear type. There are two forward speeds and reverse. The gears are cut from steel, and the differential gears are fitted with brakes for assisting steering; the steering gear can be actuated by a power-driven worm-and-wheel device or by hand. Each differential bevel and brake drum is integral with the pinion, which drives into an internal gear also cast in one piece with the driving sprocket, Fig. 103, page 188; the sprockets revolve on a fixed axle about which the track frame is pivoted. The front of each track is thus free to rise and fall independently of the other, according to the irregularities of the ground, and the effect is that of three-point suspension. The upper portion of the chain is carried on three or two wheels respectively, to limit sagging. The actual construction of the chain differs from that of other track chains that have been mentioned, as it is fitted with a rocker joint, Fig. 55, page 146 *ante*, somewhat similar to that in use on the Westinghouse-Morse noiseless drive chain. This design is intended to work dry and to avoid the wear to which chains of the ordinary pin-joint construction are exposed when running in sand and grit. As in the other tractors described, an adjustment is provided at the front end of the tracks for moving the idler shaft bearings forward to take up wear.

In the 30-h.p., Fig. 102, page 188, and 16-h.p. Tracklayers there is no front wheel, the steering being effected by side-clutches of the expanding type. Power is transmitted through a disc clutch to the gear-box. In the 30-h.p. this is fitted with two forward gears and a single reverse gear; in the 16-h.p. there are two speeds forward and the same in reverse. In both types the track frames are pivoted about the back axle and carried, near the front idler, by helical springs bearing on the main frame. In the 30-h.p. the load is carried on four wheels, and in the 16-h.p. on three wheels; in both these types the upper part of the chain is supported by a single carrying wheel. An example of the Tracklayer at work is given in Fig. 104, page 188.

(To be continued.)

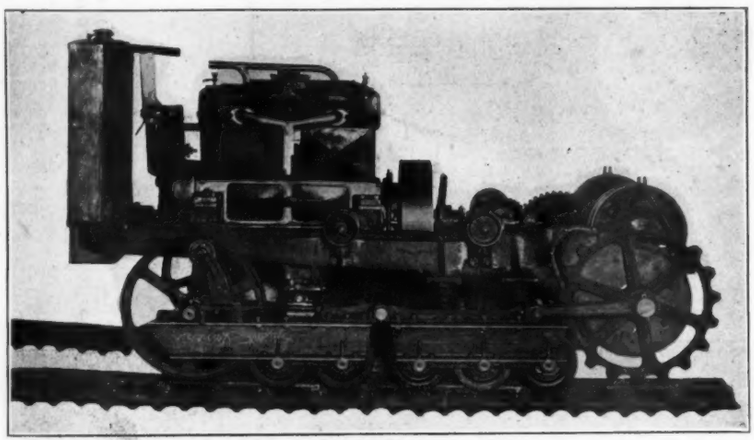


Fig. 78.

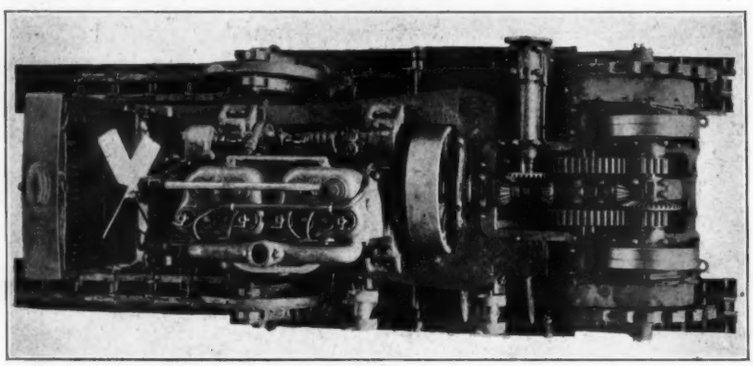
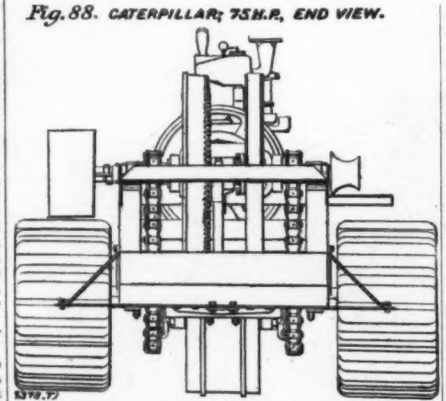


Fig. 79.

Figs. 78 and 79. The 18-H.P. Caterpillar (Holt).

Fig. 88. CATERPILLAR; 75 H.P. END VIEW.

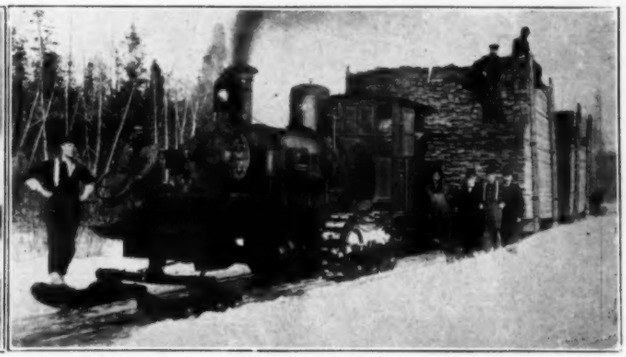


* This motor was constructed to the designs of the Ministry of Munitions Mechanical Transport Department, the Director of which was Mr. W. F. Rainforth. A very full description of the engine is given in *The Engineer*, vol. cxxiii, pages 308, 310 and 311, 314 and Supplement.

Shipbuilding in Canada.—Shipbuilding in Canada, says *The Iron Age*, New York, is showing greater progress at the present time than ever before in the country's history. New companies continue to be incorporated, backed by many millions of dollars. Since 1914, upwards of 20 large companies have been organised and are now operating plants throughout the Dominion, and the number of ships turned out constitutes a record for Canadian shipbuilding. At the present time there are 107 ships under construction in the Canadian shipyards; of these, 44 are being built on the Atlantic coast, 18 on the Pacific coast, and 45 on the Great Lakes. These represent 155,691 tons. In addition to these, a number of orders have been placed with shipbuilding concerns on the Pacific coast for additional steel freighters.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 185.)



FIGS. 62 AND 63. THE LOG HAULER, PHŒNIX.

FIG. 66.

FIG. 68.

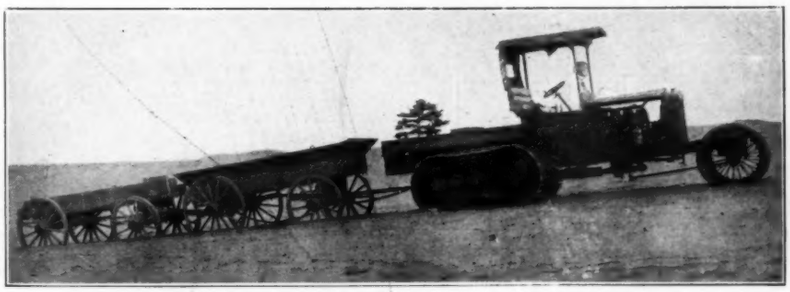


FIG. 67.

FIG. 69.

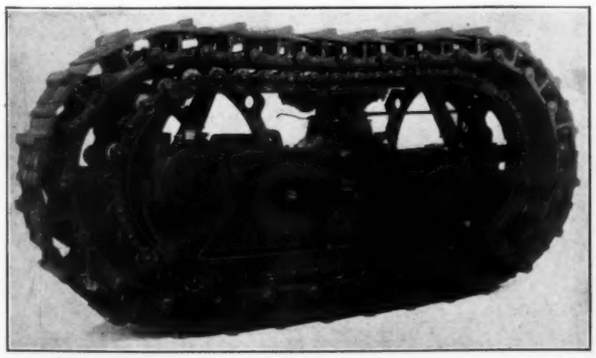


FIG. 70.

FIG. 71.

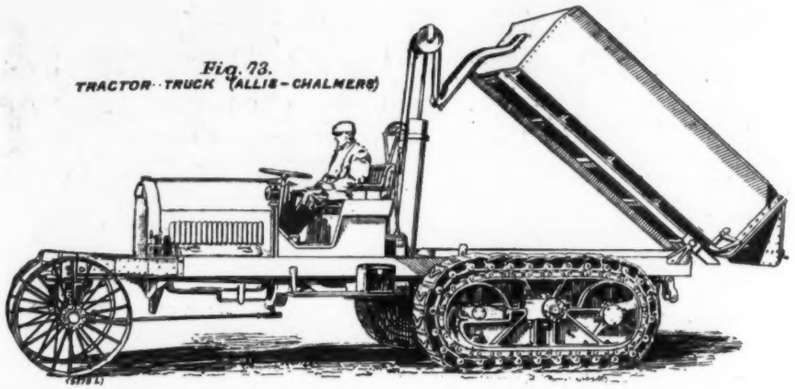
FIGS. 66 TO 71. THE CENTIPED TRUCK, PHŒNIX.

(*To face page* 186.)

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 185.)

FIG. 72. THE CENTIPED TRUCK, PHŒNIX.



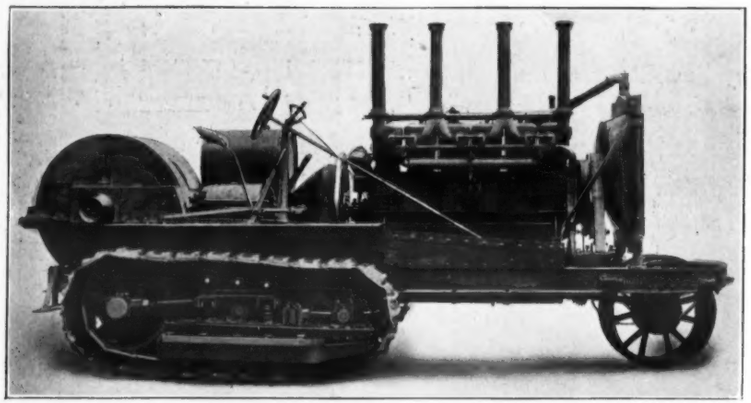


FIG. 74.

FIGS. 74 TO 77. THE CATERPILLAR (HOLT).

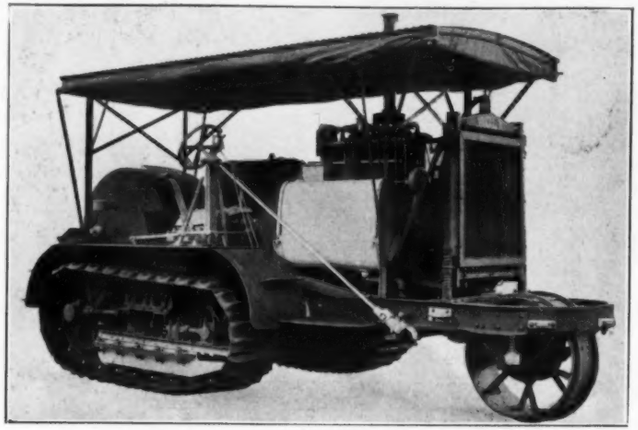


FIG. 75.

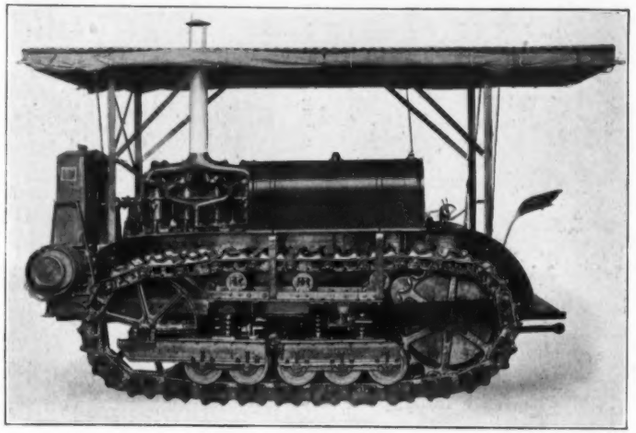


FIG. 76.

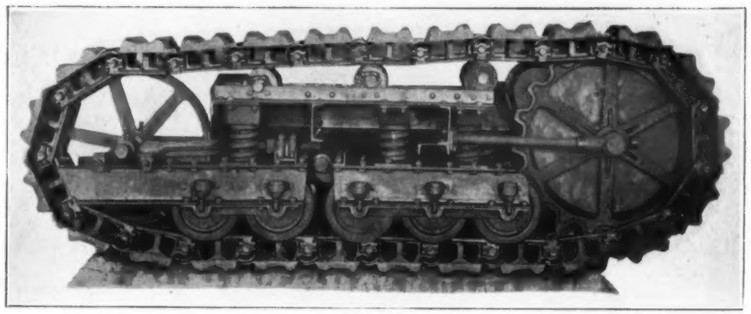
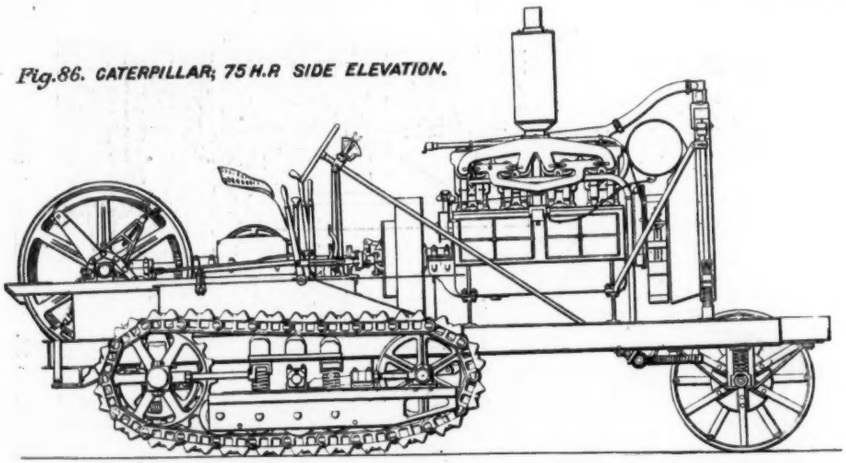


FIG. 77.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 185.)

Fig. 86. CATERPILLAR; 75 H.P. SIDE ELEVATION.



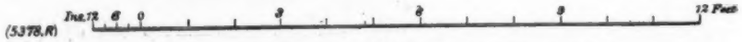
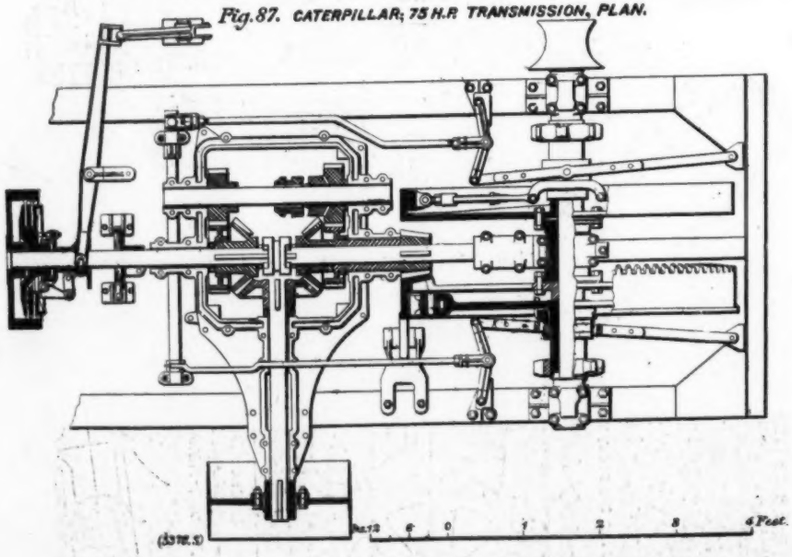
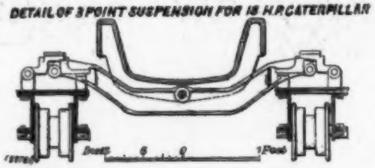


Fig. 87. CATERPILLAR; 75 H.P. TRANSMISSION, PLAN.



DETAIL OF 3 POINT SUSPENSION FOR 18 H.P. CATERPILLAR



FIGS. 86 TO 91. THE CATERPILLAR (HOLT).

Fig. 89. CATERPILLAR; 45 H.P. SIDE ELEVATION.

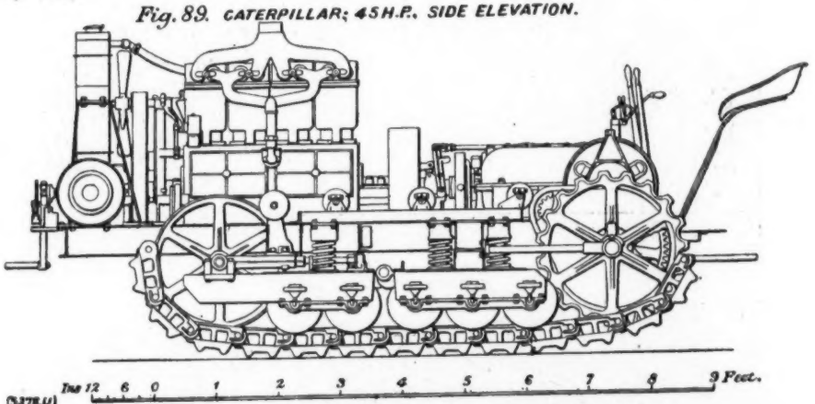


Fig. 90. CATERPILLAR; 45 H.P. TRANSMISSION, PLAN

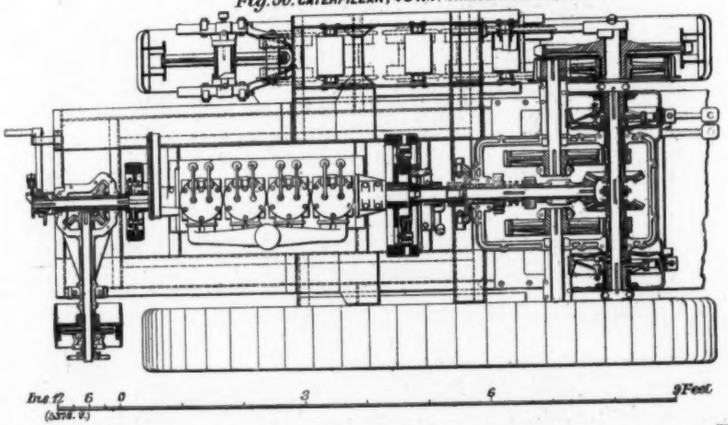
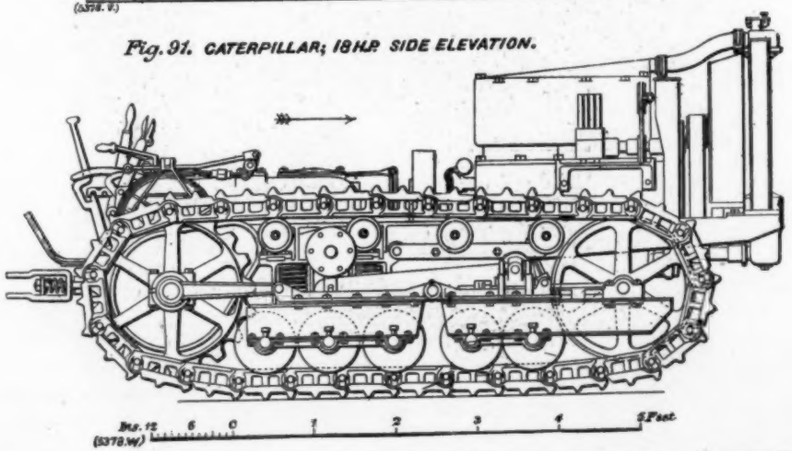


Fig. 91. CATERPILLAR; 18 H.P. SIDE ELEVATION.



TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 185.)

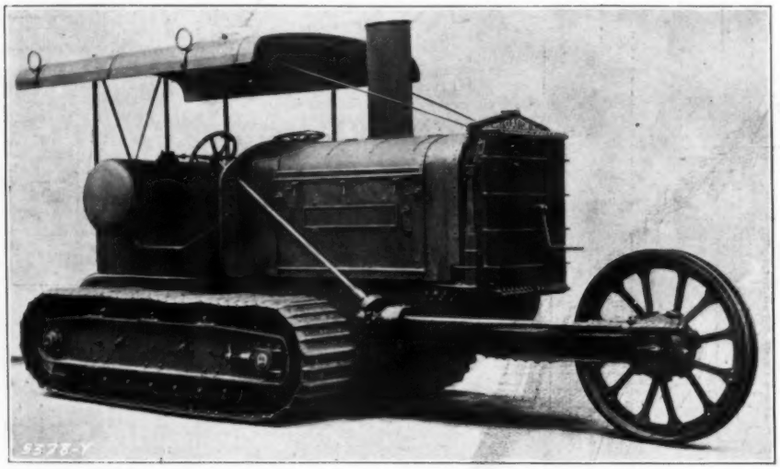


FIG. 92.

FIG. 93.

FIG. 94.

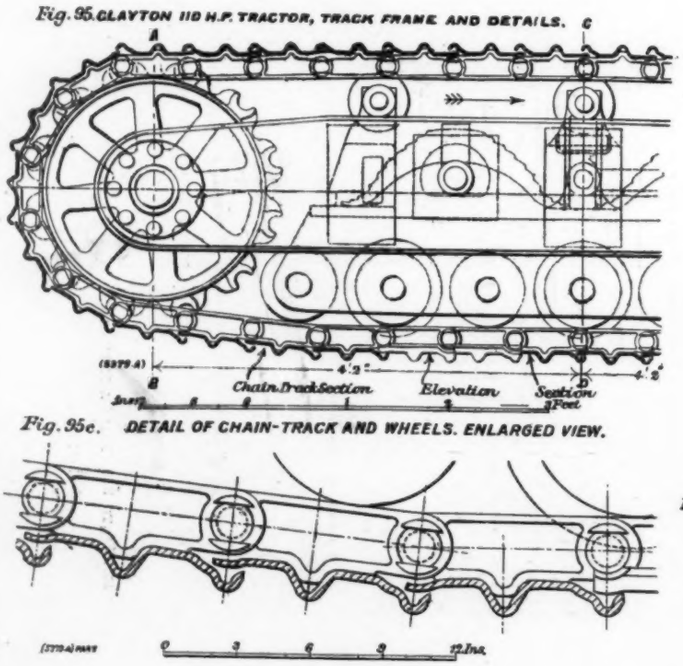
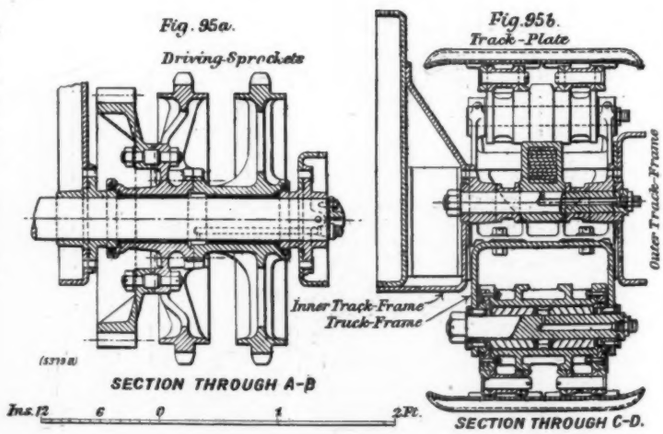


Fig. 95. CLAYTON 110 H.P. TRACTOR, TRACK FRAME AND DETAILS.
A
C
B
Chain Track Section
Elevation
Section
Ins. 12 6 0 1 2 Feet
Fig. 95c. DETAIL OF CHAIN-TRACK AND WHEELS. ENLARGED VIEW.
0 3 6 9 12 Ins.



FIGS. 92 TO 95. THE CLAYTON TRACTOR.

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(For Description, see Page 185.)

Fig. 96. CLAYTON 110 H.P. TRACTOR; FRONT WHEEL AND STEERING GEAR

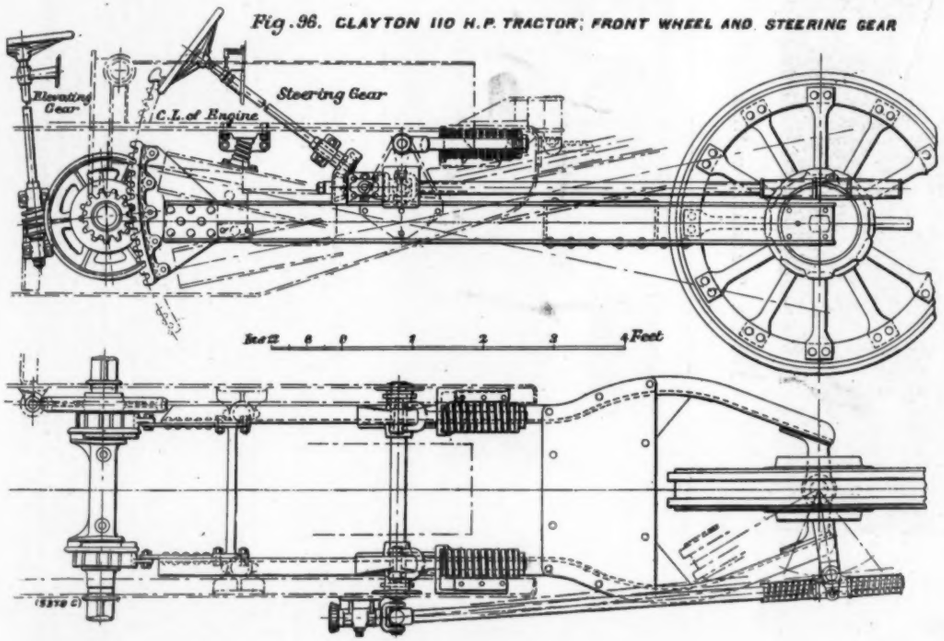


Fig. 97. CLAYTON 110 H.P. TRACTOR; SECTION THROUGH FORE-CARRIAGE

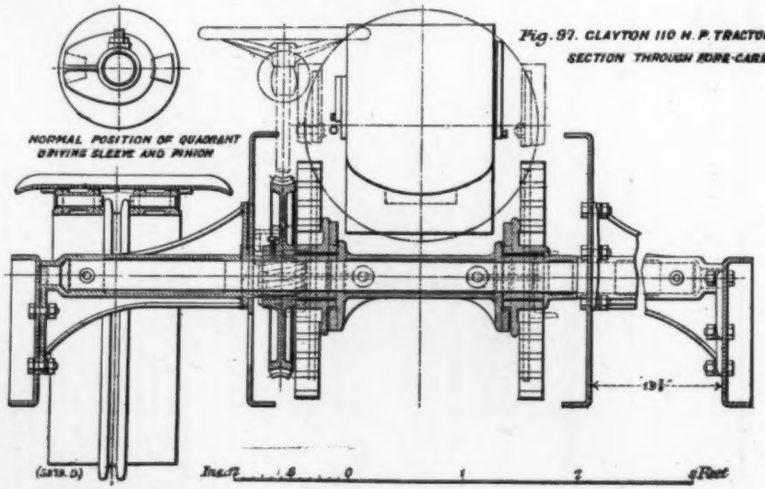


Fig. 98. CLAYTON 110 H.P. TRACTOR; FRICTION CLUTCH AND COUPLING

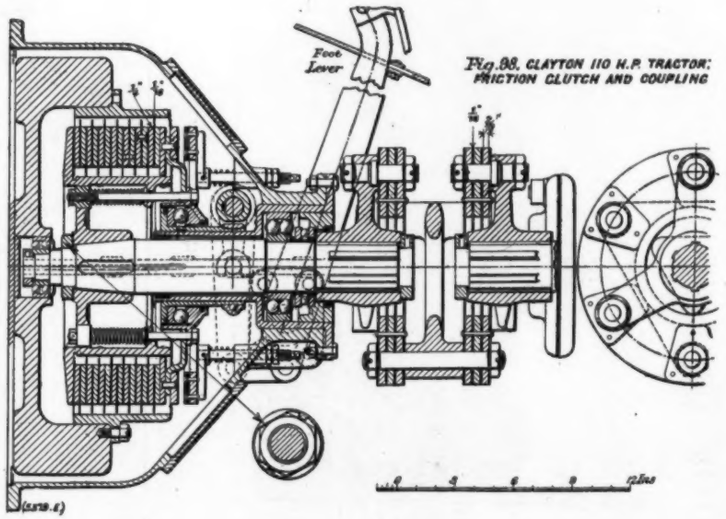
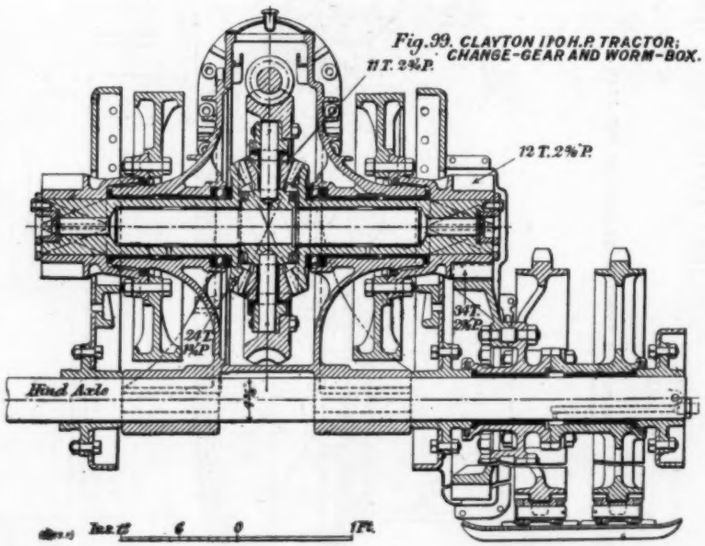


Fig. 99. CLAYTON 110 H.P. TRACTOR; CHANGE-GEAR AND WORM-BOX.



FIGS. 96 TO 99. THE CLAYTON TRACTOR.

TRACTION ON BAD ROADS OR LAND.

(*For Description, see Page* 185.)

Fig. 100. CLAYTON 35 H.P TRACTOR; ELEVATION AND PLAN.

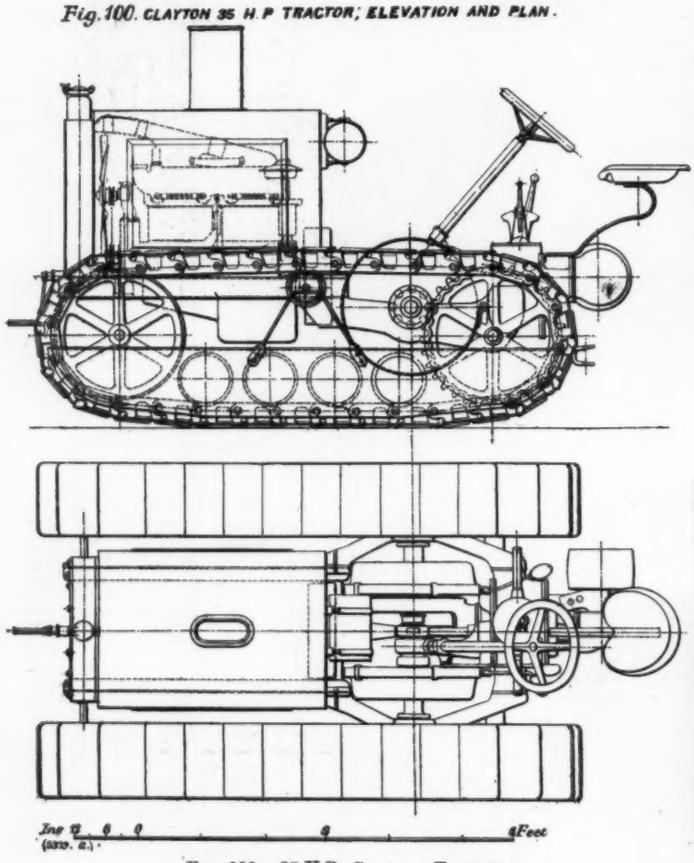


Fig. 100. 35-H.P. Clayton Tractor.

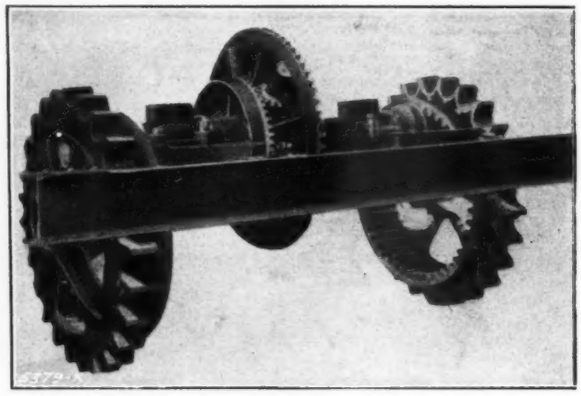


Fig. 103. Gear of Tracklayer.

Fig. 104. Tracklayer at Work.

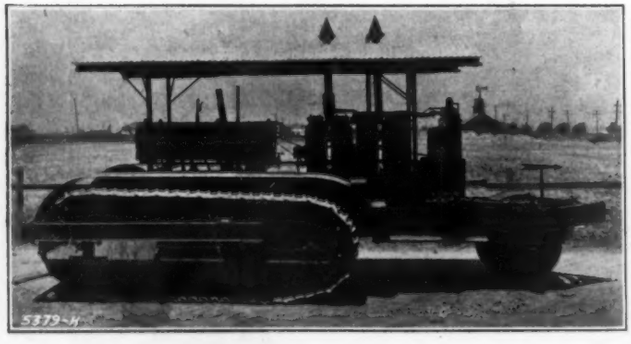


Fig. 101. 90-H.P. Tracklayer (C. L. Best).

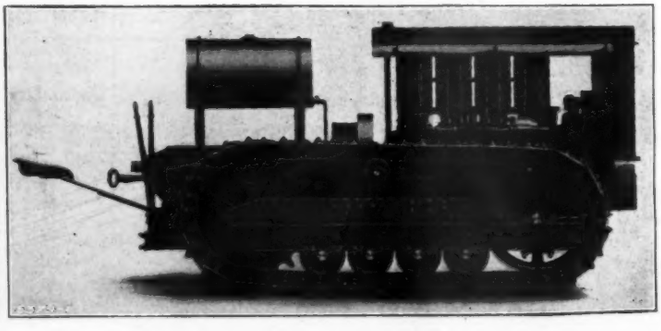


Fig. 102. 30-H.P. Tracklayer (C. L. Best).

Anglo-Norwegian Shipping.—We are informed that an Anglo-Norwegian steamer company is in course of formation in Norway. The capital is to be 35,000,000 kroner, and the new company proposes to take over contracts for 10 steamers of 10,800 tons each from the Doxford yard, in Sunderland. The steamers, it is stated, are to be delivered after the termination of the war.

The Value of Superheated Steam in Locomotives, Addendum.—In the letter by Mr. F. W. Brewer under this heading, on page 130 of our issue of February 1, a few words were inadvertently omitted in the second paragraph. The sentence "The question is, to what has this claim any foundation in fact?" should have read, "The question is, to what extent has this claim (to run superheater locomotives with a very early cut-off at all times) any foundation in fact?" In the third paragraph the sentence, "As the quantity of coal consumed per foot of grate area increases," should have read, "As the quantity of coal consumed per square foot of grate area increases."

Electrochemistry and Electrometallurgy in Switzerland, 1916.—According to the report on the Commerce and Industry of Switzerland in 1916 matters improved on the whole during that year, although the dearth of raw materials seriously interfered, for instance, with the production of ferro-alloys, especially with ferro-chromium and ferro-tungsten, of which only between 300 tons and 400 tons were produced. Of ferro-silicon, the works in Visp and Bodio exported 20,000 tons, whilst the whole production of the previous year had amounted to 14,000 tons. A new electric furnace for making cast-iron had been started in Bex; the daily production was about 30 tons. Electric steel was being produced in electric furnaces at Giubiasco. The calcium carbide production rose from 60,000 tons in 1915 to 70,000 tons in 1916; the exports of the carbide to different countries were, in 1916 (1915): To Germany, 46,200 (48,600) tons; France, 10,400 (10) tons; Belgium, 690 (3,900) tons; Netherlands, 20 (2,200) tons; the total calcium carbide exports, 58,000 (55,400) tons, were estimated at 17.4 (12.5) millions francs. The output of calcium cyanide was doubled during 1916, the production being nearly 25,000 tons; the production of carborundum and other abrasives was also nearly doubled likewise—1,500 (800) tons. Figures on the aluminium production are not given in the report; it is mentioned, however, that the exports increased, amounting to 11,400 tons, against 9,400 tons in 1915. The nitric acid works in Chippis and in Bodio produced sufficient acid from atmospheric nitrogen to cover the demand of the federation. The output of caustic soda from the works in Monthey had risen from 1,000 tons in 1913 to 2,500 tons in 1916. New chemical works had been opened at Aarau for the manufacture of hydrogen peroxide, and at Bex for electrolytic copper sulphate.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

SELECTED ABSTRACTS OF RECENT PUBLISHED SPECIFICATIONS UNDER THE ACT OF 1907.

The number of views given in the Specification Drawings is stated in each case; where none is mentioned the Specification is not illustrated.

Where inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

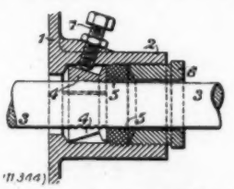
Copies of Specifications may be obtained at the Patent Office, Sales Branch, 25, Southampton Buildings, Chancery-lane, W.C., at the uniform price of 6d.

The date of the advertisement of the acceptance of a Complete Specification is, in each case, given after the abstract, unless the Patent has been sealed, when the word "Sealed" is appended.

Any person may, at any time within two months from the date of the advertisement of the acceptance of a Complete Specification, give notice at the Patent Office of opposition to the grant of a Patent on any grounds mentioned in the Act.

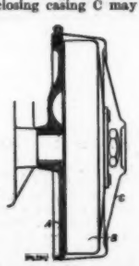
ELECTRICAL APPARATUS.

111,344. British Insulated and Helsby Cables, Limited, and R. W. Blades, Prescot. Junction Boxes. (4 *Figs.*) November 25, 1916.—This invention has reference to that kind of connections for securing electrical cables to junction boxes by means comprising a split ring or bush around the cable, and fitting within a socket, and pressed on to the cable sheathing so as to grip the latter, by means of a gland. 1 represents a part of the box into which the cable is led and to which it is secured, having upon it the neck through which the cable 3 is to be introduced or passed; 4 is a ring or collar in a plurality of parts or segments; 5 is a packing or sealing material within the neck 2; and 6 is a gland by which the packing is forced on to



the surface of the cable 3, and makes a fluid tight joint between the box and the cable. The sectional ring lies at the bottom of the neck 2, and is pressed on to the cable by three clamping-screw studs 7, one for each segment of the ring; and, as shown, the outer surface of the segments or ring is inclined and the studs are passed through the neck 2 at an inclination of 90 deg. to this incline, so as to act squarely on the ring and tend to press it inwards longitudinally, as well as radially, on to the cable 3. The interior surface of the ring 4 is serrated or corrugated or roughened or irregular, so as to bite or indent the exterior of the cable, and provide a more effective grip and anchoring of the ring with the cable. (*Accepted December* 5, 1917.)

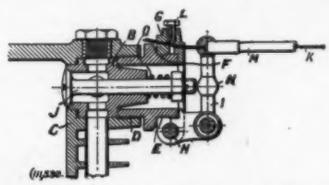
111,391. The Villiers Engineering Company, Limited, Blakenhall, Wolverhampton, G. Funck, Coventry, and F. H. Farrer, Penn. Magneto-Electric Machines. (1 *Fig.*) January 31, 1917.—This invention provides a totally-enclosed form of flywheel magneto. According to this invention, a flywheel magneto device is characterised by the back plate A being extended beyond the flywheel member B and having a light casing C secured to it, which entirely encloses the said flywheel member and all the parts embraced between it and the backplate. The enclosing casing C may be a dished stamping



which can be pushed over the periphery of the backplate A and secured by nuts or other convenient means. The edge of the enclosing casing may be slotted to receive pins in the periphery of the backplate which carry the fastening nuts, and the slots, if desired, may be made of the bayonet type, in which case the nuts either serve to fix the cover when in position, or may be dispensed with and the bayonet action relied upon to hold the cover in place. Preferably the backplate is adjustable through a small angle on its support, which is concentric with the engine shaft, so that its angular position may be varied for timing the ignition. (*Accepted December* 5, 1917.)

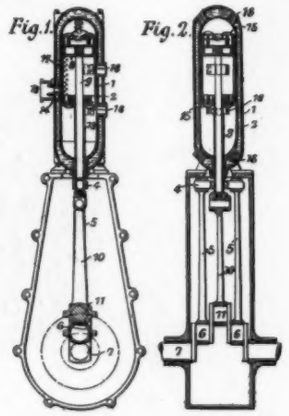
GAS ENGINES, PRODUCERS, HOLDERS, &c.

111,590. The Villiers Engineering Company, Limited, Blakenhall, Wolverhampton, G. Funck, Coventry, and F. H. Farrer, Penn. Internal-Combustion Engines. (2 *Figs.*) February 8, 1917.—This invention relates to spring-closed release valves for internal-combustion engines of the type employing a split tubular clip or collar which grips the externally projecting portion of the casing or body of the valve and also carries a pivoted lever adapted to open the valve when operated by a Bowden wire or the like. According to this invention, the lever at one end is hinged to and extends across the collar so as to engage the end of the valve stem, and the Bowden wire passes through the free end of the lever and is connected to the collar while the Bowden wire casing butts against the lever. A shouldered valve-carrying plug B is secured in the wall C of the engine cylinder and clamped in place by an externally screw-threaded sleeve D. E is a tubular extension having a circumferential recess F. A split collar G is shaped to engage the recess F is sprung on to the extension E, and the split side is clamped together by a screw H which passes through jaws provided at that side. The lever I is pivoted by one end between the jaws and extends diametrically across the collar so that the lever lies right across the end of the valve stem J. A Bowden wire K enters an orifice in the end face of the collar and is secured therein by a gripping screw L. To reach the collar, the Bowden wire is carried through the free end of the lever I, and the casing M of the wire is butted against the free end of the lever. The central portion of the lever has an enlargement N which bears upon the end of the valve stem J or lies in close proximity thereto. The operation of this device is as follows: The operation of the usual



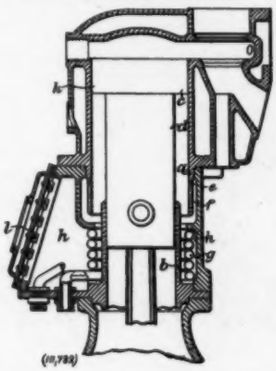
Bowden-wire lever causes an endwise thrust on the casing M, which advances the lever I lying across the end of the valve stem, and thus opens the valve against the action of its spring O; as soon as the Bowden wire lever is released the parts return to the closed position. (*Accepted December* 12, 1917.)

111,632. J. B. Price, Crosskeys, near Newport, and The Ebbw Vale Steel, Iron and Coal Company, Limited, Ebbw Vale. Internal-Combustion Engines. (2 *Figs.*) May 4, 1917.—This invention has reference to double-acting internal-combustion engines with a pair of working pistons connected together and an intermediate pump piston reciprocating within a cylinder and so arranged that during each stroke a charge will be drawn in between the one side of the pump piston and the adjacent working piston, whilst the previously drawn-in charge on the other side of the pump piston will be compressed into the space beyond the adjacent working piston ready for ignition and two impulses or power strokes obtained in each revoluion of the crankshaft. According to the present invention, the working pistons and the pump piston are connected to aligned cranks of a common crankshaft, the arrangement being such that the pump piston will travel faster than the working piston. The working pistons are constituted by the ends of the hollow piston 1 reciprocating within the cylinder 2 and connected by means of a sleeve piston rod 3, with a cross-head 4 that is coupled by connecting rods 5 with the cranks 6 of the crankshaft 7. Within the hollow piston 1 is the pump piston 8 which is reciprocated through the piston rod 9 and the



connecting rod 10 from a crank 11, between and in alignment with the side cranks 6 of the crankshaft, and having twice the throw of said cranks. Owing to the radius of the crank 11 being greater than the radius of the cranks 6, the pump piston 8 moves with a greater velocity than the hollow piston 1 and, on each stroke of the piston 1, creates a partial vacuum between its upper surface and the upper end of the piston 1, or between its under surface and the lower end of the piston 1; during each stroke the piston 8 overruns the mid-cylinder inlet port 13 and, owing to atmospheric pressure, the automatic valves 14 open, and thus allow the charge to pass to and through the perforations 17 in the wall of the hollow piston and to fill the partial vacuum in said hollow piston behind the pump piston. On the return stroke of the pump piston 8 in either direction, the charge is forced through the valves 15 in the end of the piston towards which it is moving into the corresponding end of the cylinder, and is fired at the end of the stroke in the usual manner by one or other of the sparking plugs 16 in the cylinder ends. The exhaust products escape through ports 18, which are uncovered at the proper times by the hollow piston 1; the springs of the valves 15 are so adjusted that the valves will open after the ports 18 have been again covered. (*Accepted December* 12, 1917.)

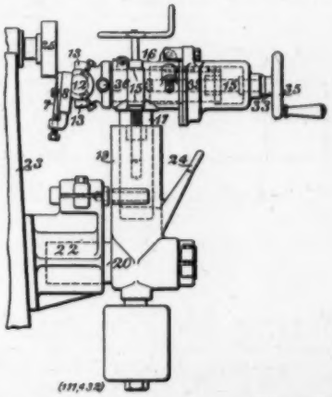
111,792. Peter Brotherhood, Limited, and C. W. Bryant, Peterborough. Internal-Combustion Engines. (1 *Fig.*) April 25, 1917.—The invention relates to internal-combustion engines of the super-compression or supercharging type, in which pipes through which cooling water circulates are provided for cooling the precompressed charge of air or exhaust gas, or a mixture of both, prior to its admission to the power cylinder for scavenging or supercharging. The invention consists in placing the cooling coils in such a position that the supercharging or scavenging fluid passes in contact with them during its induction and also during its compression by the outward movement of the piston and its passage from the supercompression chamber to the combustion chamber. The cylinder is formed of two parts *a*, *b*, in which work a differential piston *c*, *d*, the lower part of the cylinder *b* serving as a guide and being arranged so that the piston *c* towards the end of its stroke overruns ports *e* leading to the lower part of the cylinder from an annular space *f*, in which the supercharging fluid has previously been compressed. During the compression the contents of the annular space *f* are forced through spaces between the cooling coils *g* situated in a chamber *h* surrounding the trunk guide *b*, this space being large compared with the annular space *f*, which becomes smaller in relation to the chamber towards the end of the stroke of the piston. As soon as the ports *e* are uncovered at or towards the end of the stroke, the compressed contents of the chamber *h* return past the cooling coils *g* and flow into the cylinder, thus being further cooled before their entry into the combustion space *k*. This action takes place both with the scavenging charge, which is admitted at the end of the power stroke, and also with the supercharge, which is admitted through the same ports at the end of the induction stroke. A valve plate *l*, fitted with sheet or other automatic or positively-operated valves, is provided at the side of the cooling chamber *h*, and serves to admit the super-



charging and scavenging air during the upward travel of the piston. The spaces between the coils *g* may be varied to ensure equal distribution of the charge between them so that efficiency of cooling is maintained. The velocity of the air or gases between the tubes *g* is kept relatively high, so that the cooling surfaces are to a great extent self-cleaning. (*Accepted December* 19, 1917.)

MACHINE AND OTHER TOOLS, SHAFTING, &c.

111,432. T. Lumsden, Gateshead. Tool-Grinding Machines. (4 *Figs.*) May 16, 1917.—This invention relates to tool-grinding machines and provides improved means for "lipping" the cutting edges of "spade" and like cutters. According to the present invention, a tool-grinding machine is provided with an attachment comprising a clamp 8 adapted to receive and hold a spade or like cutter 7, said clamp being characterised in that it is mounted so that it can be oscillated about either of two axes, each of which is parallel to the axis of the grinding wheel or disc 25. The clamp 8 is carried by a bar 12 capable of adjustment in jaws 13 about an axis parallel to the face of the cutter 7 and to the face of the grinding wheel 25. The jaws 13 are carried by a horizontal spindle 15 mounted in



a barrel 16 carried by a vertical trunnion 17 in a boss 19 carried by a horizontal trunnion 20 in a bracket 22 on the frame 23 of the grinding machine. It will be seen that the attachment can all be oscillated by means of the handle 24 about the axis of the horizontal trunnion 20, which axis is parallel to the axis of the grinding disc 25. The horizontal spindle 15 can be adjusted axially in the barrel 16 to travel the clamp 8 and cutter 7 towards or away from the cutting edge of the grinding disc 25 by means of a threaded shaft 33, which can be rotated by a hand wheel 35. The jaws 13, bar 12, clamp 8 and cutter 7 can be oscillated by means of the handle 36 about the axis of the horizontal spindle 15, which axis is parallel to the axis of the grinding disc 25. (*Accepted December* 5, 1917.)

MINING, METALLURGY AND METAL-WORKING.

111,592. T. G. Wrightson, J. M. Ringquist, and Head, Wrightson and Co., Limited, Thornaby-on-Tees. Charging Blast Furnaces. (3 *Figs.*) February 15, 1917.—This invention relates to hoists adapted for charging blast furnaces. According to this invention, means are provided for holding the centre of gravity of the skip a greater distance from the vertical line through its point of suspension than the maximum acceleration or retardation of the carriage would tend to cause such centre to move. 4 is a carriage which supports a skip 5 and runs on rails 7 on the hoist. The carriage is raised and lowered by a hoisting rope 8. The skip 5 is lowered by means of a rope 13. The carriage 4 consists of two cross-heads 15, 16, of the width of the hoist frame connected together by a toggle lever whose two members 17, 18, are pivoted together at 19, a friction roller 20 being mounted upon the pivot. The hoisting rope 8 is connected to the lower crosshead 16, and a chain 21 for supporting the skip passes over a chain wheel 22, and is also attached to the crosshead 16. The lowering rope 13 is attached to the crosshead 16. On the hoist frame is a guide 23, upon which the friction roller 20 runs, causing the toggle levers to hold the crossheads 15, 16, apart. At the top of the hoist the guide 23 extends away from the hoist as is shown at 24, thus leaving the pivot 19 unsupported and allowing the crosshead 16 to approach the crosshead 15 under the action of the weight of the skip 5. The lowering of the skip to the mouth of the furnace is controlled by the rope 13. The skip is prevented from swinging by means of a lever 25, one end of which is pivoted to the carriage

at 26 and at the other end is a crutch 27, which embraces the skip as shown. Upon the lever 25 is a roller 28, which runs in a guide 29 on the hoist frame, the guide being so formed as to cause the crutch 27 to retain the skip 5 in the desired position in the course of usual working. In order to facilitate the engagement of the crutch 27 with the skip 5 at the commencement of its movement,

Fig. 2.

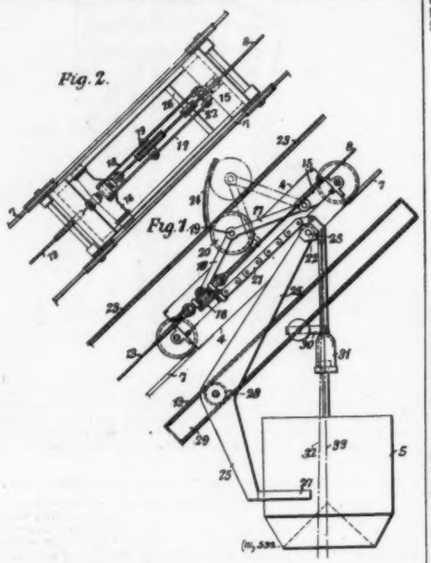


Fig. 1.

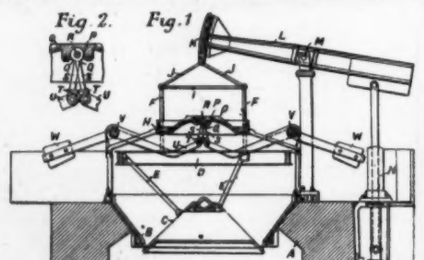
(111,593.)

a weighted arm 30 is pivoted to a hook 31 at the end of the chain 21, by which means the skip when starting is first slightly moved away from the crutch 27. In Fig. 1, 32 is a vertical line, whilst the line 33 is drawn through the point of suspension and centre of gravity, thus illustrating the position in which it is desired that the skip should be retained. (*Accepted December* 12, 1917.)

111,593. T. G. Wrightson, J. M. Ringquist, and Head, Wrightson and Co., Limited, Thornaby-on-Tees. Blast Furnaces. (3 *Figs.*) February 15, 1917.—This invention relates to blast-furnaces of the type in which the furnace mouth is closed by a bell above which is a seal normally held closed by weighted levers. According to this invention, the bell is suspended by links from a ring which is suspended from four links passing through stuffing-boxes at the top of a casing at the top of the furnace. These links are connected together in pairs, each pair being connected to a beam. The walls A of the furnace carry a ring B, which forms a seating for a bell C. The bell C is suspended from a ring D by three links E. Connected to the upper side of the ring D are four links F passing through stuffing-boxes in the casing H of the furnace and connected together in pairs by rods I. Each link F is connected by another link J

Fig. 2.

Fig. 1.

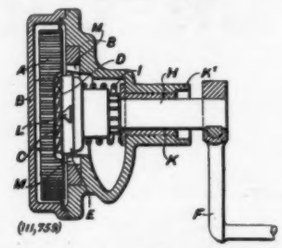


(111,593.)

to a chain K attached to one or other of the beams L pivoted at M and actuated by hydraulic ram N. Above the bell C is a seal O at the top of the casing H. On the underside of the seal O is globular socket P containing hemispheres Q, whilst a pin R passes through the socket P and the hemispheres Q. The hemispheres are connected to arms S whose bifurcated ends T are pivoted to levers U mounted on shafts V, and having weights W which tend to retain the seal O against the casing H. The skip is lowered on to the seat *b* and the bottom of the skip is lowered together with the charge, which in their descent press down the seal O, allowing the charge to be delivered from the skip on to the bell C. When the charge has been delivered, the bottom of the skip is closed and the seal O is raised by means of the weighted levers U. The beams L are then moved by the hydraulic ram N, thereby lowering the bell C and allowing the charge to enter the furnace. (*Accepted December* 12, 1917.)

MOTOR ROAD VEHICLES.

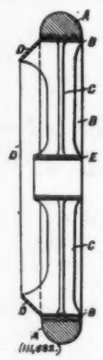
111,759. Triumph Cycle Company, Limited, and G. E. Stanley, Coventry. Starting Gear. (1 *Fig.*) February 10, 1917.—This invention relates to kick starters for motor cycles. The invention comprises the combination of spring-engaged bevelled clutch members, and oppositely-inclined cam surfaces on the driving clutch member adapted to engage respectively similar surfaces on an adjacent rigid stationary member when the said clutch member has rotated through an arc in either direction, whereby the driving-clutch member is moved axially out of engagement with the other clutch member. A spur gear A is mounted in the gear-box B so as to engage a pinion on the driving shaft. The boss of the spur gear is provided with inclined clutch teeth C adapted to engage similar teeth D on the driving-clutch member E, which is operated by the kick-starter lever F of known type. The driving-clutch member F can slide axially on keys on the starter shaft H, but cannot rotate thereon, and the said clutch member is pressed forward into engagement with the spur wheel by a cylindrical helical spring I mounted between the clutch member and a collar on a bush K, which collar, on the other side, bears against the end of bearing K1 in the gear casing. The starter shaft H extends outside the casing and is provided with the kick-starter lever F, of the known type. On the periphery of the clutch member E and just behind the inclined clutch teeth D, a projection L is formed, having oppositely-inclined cam surfaces, which, when the clutch member has revolved in either direction through an arc of about 100 deg. to 130 deg.,



(111,759.)

engages respectively at each end of the arc a similar cam surface M on the gear casing, which cam engagement moves the clutch member axially out of engagement with the spur gear. The usual spring (not shown) which normally holds the starter lever in the starting position, causes the driving clutch member E to remain normally rotated out of engagement with the spur gear A. If a back-fire occurs, the parts are automatically disengaged by the inclined cam surfaces. (*Accepted December* 19, 1917.)

111,682. The Dunlop Rubber Company, Limited, Westminster, London, and C. Macbeth, Aston, Birmingham. Wheels. (5 *Figs.*) September 1, 1916.—This invention relates to wheels for road vehicles. According to this invention, there is provided on either or both sides of the wheel, a protector extending laterally from a point adjacent to the juncture of the tyre and the wheel rim or felloe and inclined inwardly so that the outer or inclined face of the protector on coming into contact with the kerb or other obstacle will prevent the tyre from contacting therewith and mounting the same, thus preventing damage to the tyre. A indicates the tyre on the wheel, B the wheel rim on, or in which, the tyre is mounted, C the spokes,



(111,682.)

and D represents the aforesaid protector in the form of a continuous flange at the outer side of the wheel, which flange, as shown, extends laterally from a point adjacent to the juncture of the tyre and wheel rim, and is inclined inwardly, *i.e.*, towards the axis of rotation of the wheel. Referring to the example illustrated, which is a cast-metal wheel, the protecting flange D is cast in one with the wheel rim or felloe B, the spokes C and the hub E, the spokes C being shaped or outwardly-curved at their outer ends and edges to join with the inner side of the protecting flange so as to form a support for, and thus strengthen, the latter. This type of wheel is especially intended to receive a solid tyre A, as shown. (*Accepted December* 19, 1917).

111,752. The Jandus Arc Lamp and Electric Company, Limited, and A. Denman-Jones, Holloway, London. Differential Gearing. (2 *Figs.*) January 25, 1917.—This invention relates to improved differential gearing especially applicable to motor cars in which a driving shaft drives a driven shaft through planet pinions carried by a planet cage which can

Fig. 1.

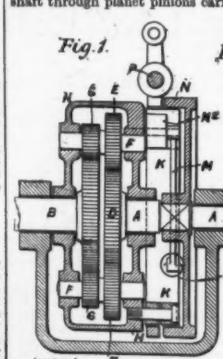
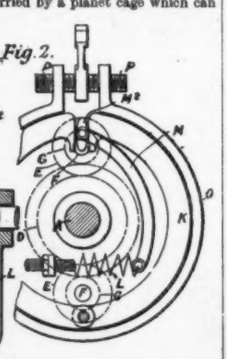


Fig. 2.

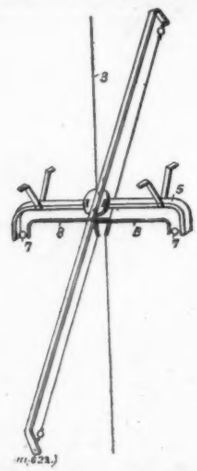


(111,752.)

be secured to the driving shaft by a clutch. According to this invention, upon the end of the driving shaft A is mounted a toothed wheel D which gears with pinions E secured to co-axial pinions G mounted upon shafts F, carried in bearings on a planet cage H, free to turn upon the same axis as the driving shaft A. The pinions G gear with a toothed wheel J upon the driven shaft B. A clutch band K is attached to the cage H, and a spring L is attached to one end of an arm M, whose other end has secured to it a cam M2 which engages with the ends the clutch band K, constantly pressing the band K outwards into contact with the inner flange of a drum N on the driving shaft A. Round the band K is a brake band O actuated by a double screw P carried on the frame of the car. When the brake O is not in action the driving shaft is coupled to the driven shaft B, as the clutch band K is in contact with the inner flange of the drum N, but when the brake O is in action the band K is freed from the drum and the cage H is prevented from rotating; consequently the pinions E, E, and G, G, in the cage H, come into operation and the shaft B is driven through them. (*Accepted December* 19, 1917.)

RAILWAYS AND TRAMWAYS.

111,822. P. Dawson, and F. W. Fawdry, Westminster London. Trolley-Wire Systems. (1 *Fig.*) September 20, 1917.—This invention relates to improvements in connection with trolley-wire systems for use on electric railways, and has for its object the provision of a flexible and self-contained change-over contacting device between the terminal ends of overlapping conductors where sliding surface contactors are employed, and is characterised by the employment of a common compression member 1 adapted to receive the terminal ends of the conductors 3, and within its length to provide "pull off" or deflecting tension members 8 adapted to give a predetermined angle within adjustable limits to the conductors 3, so that the alignment of the latter are to a greater or lesser extent parallel with the alignment

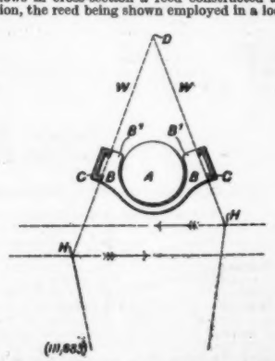


(111,822.)

of the compression member 1, the tensions in the two conductor wires thus counteracting each other in the compression member without the use of external anchorage. The length and shape of these pull-offs 8 are such that at the point of attachment to the conductor wires 3 the conductor wires are separated from each other in a horizontal plane, so that there is no electrical contact between them until the space is bridged by the sliding collector device, and they are so arranged that the collector device in passing along the rail-parallel conductors does not come in contact with any part of the deflector member 5 or the pull-off arms 8. It is also important that the point of attachment of these pull-offs to the insulators 7 should be in the same horizontal plane as the attachment to the conductor wires 3. (*Accepted December* 19, 1917.)

TEXTILE MACHINERY.

111,683. The Pneumatic Loom Syndicate, Limited, Birmingham, and M. T. Pickstone, Prestwich, Manchester. (1 *Fig.*) October 4, 1916.—This invention relates to weaving looms in which the shuttle is operated pneumatically. The invention comprises a reed, the members of which are so formed or shaped as to provide a race from which the shuttle is prevented from escaping otherwise than longitudinally, the reed plates which constitute the reed being undercut at the ends to engage with similar grooves in the supporting rails. The drawing shows in cross-section a reed constructed according to this invention, the reed being shown employed in a loom in which



(111,683.)

the warp threads ascend in an approximately vertical line from the beam to the fell of the cloth. With reeds of the type indicated a shuttle of tubular form is employed as indicated at A. The reed is made up of a number of metal plates B. The members B have crescent-shaped holes formed in them centrally, the distance between the horns B1, B1, being less than the diameter of the shuttle. The warp threads—shown in an open-shed position—are indicated at W, the heald eyes at H and the fell of the cloth at D. The reed members B are held in position by two grooved rails C; the ends of the reed members B are dovetailed to fit into the groove of C as shown. With this type of reed the ordinary shuttle race provided by the upper face of the slay is dispensed with. (*Accepted December* 19, 1917.)